



Demographic Change and Transport

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Publication date:
2013

[Link back to DTU Orbit](#)

Citation (APA):
Haustein, S., Siren, A. K., Framke, E., Bell, D., Pokriefke, E., Alauzet, A., Marin-Lamellet, C., Armoogum, J., & O'Neill, D. (2013). *Demographic Change and Transport*. European Commission. <http://consolproject.eu/>

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Road Safety in the Ageing Societies

Demographic Change and Transport

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CONSOL, Work package 1

Final Report

February 2013



WP1: Demographic Change and Transport

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CONSOL is a project co-funded by the European Commission –
Directorate-General for Mobility and Transport



Preface

This report is the literature review on demographic changes and transport of Work Package 1 of the EU project CONSOL, “CONcerns and SOLutions – Road Safety in the Ageing Societies” (contract period: 2011-2013).

The report is a state-of-the art report that combines current knowledge with new findings from relevant fields of basic research, focusing on the increasingly heterogeneous nature of the ageing population.

All CONSOL partners contributed to the report by writing parts of the report (authors), participating in the literature research and/or commenting to earlier versions of this report.

We would like to give special thanks to Heather Ward for constructive suggestions and inspiring comments to an earlier version of this report.



WP1: Demographic Change and Transport

Preface & Executive Summary



Executive Summary

The percentage of the older population in relation to the younger population is growing in Europe. The ageing population is increasingly diverse with regard to age, socio economy, health and household structure. In addition, the majority of the older population is female. The percentage of women rises with age to above 60 percent for those aged 80 and over. While household structure and income of the older generation differs greatly within Europe, we find an overall increase of single-person households, especially for older women. Against this background, this report provides a concise state-of-the-art review of what is currently known about the growing number of older road users in terms of mobility and safety. The main difference between this report and others in this field is its focus on the **heterogeneity** of the older population and the inclusion of new findings from relevant fields of **basic research**.

In Chapter 3, the issue of ageing and transport will be introduced through a review of recent research on senior mobility and safety. The review focuses on well-being implications of mobility, senior travel patterns and preferences, car driving, and safety. The general conclusions are as follows:

While older persons travel less than younger persons generally, there is a notable increase in travel activities, licensing rates and car access for the older population during the last decades. It can be expected that in the future, older persons will be more mobile and car-reliant.

In terms of safety, the chief hazard to older road users relates to those that are unprotected – pedestrians and cyclists. Older drivers, on the other hand, have an enviable safety record, and the fact that this occurs in the face of increasing levels of age-related disease and disability, which might affect driving ease and safety, is a potent metaphor for the gains of ageing, whereby wisdom and strategic thinking compensate for these deficits.

Many older persons, especially older women, choose to cease driving prematurely. This may lead to unwarranted mobility loss. The current research advises against any measures that may encourage older drivers to give up driving too early, such as age-based mandatory driver screening.

Chapter 4 focuses on the heterogeneity of the older population. Certain subgroups are of special interest here, namely those which are growing (oldest old, older women and persons in single-households), those which appear especially disadvantaged and at risk of social exclusion (e.g. low income groups, rural residents), and those for which both criteria apply (e.g. ethnical minorities). Results, which are based on a systematic literature review, are provided for each sub-group separately with regard to mobility and safety. Knowledge on **gender** and mobility has increased in the last few years, for example with regard to women's dependency on others, reasons and consequences of driving cessation, and (unfulfilled) mobility needs. It has been found that older women in particular tend to give up driving too early, often because they lack confidence or are discouraged by their husbands or licence policies. Increasing women's confidence and experience in

driving is thus identified as a way to keep older women safe and mobile. In several studies reviewed in this report, interactions of female gender and other socio-demographic variables have been found, showing that **lower income** or living in a **single-person-household** has different implications for women and men. The effects of gender, income and household structure should be examined further in future research to come to less controversial results as found in the existing literature.

Mobility options and traffic safety also vary considerably between different regions. The on-going urbanization leaves **rural areas** worse-off in terms of services and public transportation, which increases the car dependency of seniors residing in these areas. On the other hand, urbanization means that an increasing number of persons are growing old in urban environments, which puts pressure on the urban planning and development of age friendly cities, transport and mobility services. Perceived danger is a concern especially of residents of **high-density urban areas** and in the growing groups of older women, the oldest old and ethnical minorities.

However, studies on mobility and **migration background** are very limited in Europe. The situation gets even worse with respect to older people's mobility. As a first step, the respective variables should be integrated in national travel surveys like those already practised in the UK. Besides descriptive results, more in-depth research on cultural effects on travel behaviour and effects of travel socialisation are needed to explain possible differences and provide suitable measure to face possible mobility problems at an early stage of immigration.

Because of the interactions of different variables, it is useful to look at segments of the older population, which take into account several variables at once. Different existing segmentations of older people have been compared with the conclusion that it makes sense to distinguish between four types of older road users: A car dependent type that is restricted in mobility (often living in more peripheral areas); a better-off car-oriented and highly mobile type; a more self-determined type that is open to all transport modes and finally captive public transport users, which are predominantly women. Accessibility appears to be a key variable for older people to stay mobile and keep a high level of quality of life. While in districts of high accessibility restricted car access can be compensated by good infrastructural conditions, for older people living in the suburbs improvements of accessibility are necessary to ease car dependency.

As addressed in Chapter 5, there are disciplines, in which empirical, theoretical, and methodological advances are useful, if not necessary, for further understanding and studying the issue of ageing and transport. These include gerontology and geriatrics, traffic psychology, differential psychology and neuropsychology, and social and political sciences. Future studies on ageing and transport should increasingly draw upon the theories and new findings from these disciplines.

Finally, in Chapter 6, the main implications, knowledge gaps and future research directions as addressed in this summary are described in more detail.

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1 Introduction

The increased longevity in the 20th century is a major social advance comparable to the reduction of child and infant mortality in the 19th century. This rapid ageing of our populations poses both great opportunities but also significant challenges. The opportunities, sometimes termed the longevity or demographic dividend (Murphy & Topel, 2006; O'Neill, 2011), range from the personal (increased wisdom and strategic thinking) through to the societal and the financial: the longevity dividend was estimated to add £40 billion to the UK economy in 2010. The challenges arise from increasing levels of age-related disease and disability, economic vulnerability and negative societal attitudes to ageing (ageism) and further complexity is added to the picture by one of the key hallmarks of later life, increased inter-individual variability. Increased complexity is therefore a defining characteristic of later life, and it is not surprising that this complexity requires a more sophisticated palette of options for the transportation system as well (Coughlin, 2009).

In Europe, the proportion of those aged over 65 as a percentage of the population aged 20-64 years, will double between 2010 and 2050 according to Eurostat projections (Lanzieri, 2011). The changing demographic composition of road users will be described in the following chapter. It is assumed to have an impact on many factors, for example, travel demand, infrastructure needs, traffic safety, and climate impacts.

The research conducted during the last 15-20 years has significantly contributed to our knowledge about mobility and travel behaviour in old age. This knowledge is briefly summarized in Chapter 3.

Chapter 4 describes the implications of different aspects of demographic change on older people's mobility and safety. Besides ageing, demographic change is also characterised by individualisation, visible, for example, in an increasing share of single-person households and alternative living arrangements, and by internationalisation (a growing share of people with an immigration background in the European population). Previous research activities have often resulted in recommendations, policy advice or measures that neglected the diversity and heterogeneity of old and ageing population. Policies lack gender sensitivity even if we know that the majority of the older population is female and that mobility in old age is experienced and lived differently by men and women. Similarly, economic, ethnic and cultural, and geographic variations are often neglected. Chapter 4 provides a subchapter for each of these criteria, completed by an overview on segmentation studies on older people based on multiple criteria.

Ageing and transport is often presented as a policy issue located in the transport sector. It is a multifaceted challenge, but one that also has the potential to afford significant economic opportunities for the European Union. These may be either through the elimination of unnecessary morbidity and

institutionalization of older people by providing access to age-attuned transport, but equally the complexity of the market provides opportunities for new markets and technological developments for European industry. Knowledge-based policy making originates from several disciplines. Similarly, the potential solutions need to be realized on different sectors instead of being limited to the transport sector. The disciplines having a key role in producing relevant knowledge to the policy making needs regarding ageing and transport include naturally research on traffic behaviour, but also social and political sciences, gerontology and geriatrics, and neuropsychology. In order to understand the challenge the societies are facing sufficiently, it is necessary to have an up-to-date, multidisciplinary comprehension of the nature of the issue, which we provide in Chapter 5.

Finally, Chapter 6 summarises the main implications of demographic change with regard to older road users and identifies relevant knowledge gaps future research should focus on.

2 Demographic change and the ageing population in Europe

This Chapter provides an overview of the main drivers of demographic change and describes the structure of the European population today and expectations for the future. Further, an overview of the economic and social situation of older people in Europe is given.

2.1 Main drivers of the demographic change: fertility, life expectancy, and migration

Demographic change in Europe¹ is mainly driven by three determinants: fertility, life expectancy and migration. These three determinants are shown in an overview on the forthcoming pages, based on the report on demographic change 2010 by the European Commission (EC, 2010). Europe is not a homogenous place regarding the demographic structure, and large differences exist between the different regions. This section focuses on average data for all European countries, but country specific details are provided when relevant for this report.

2.1.1 Fertility

In the second half of the 20th century, all European countries experienced all-time lowest fertility rates (fewer than 1.3 children per woman). While the rates have risen to an average of 1.6 (see Table 1), countries like Hungary, Germany, Austria, Spain and Poland still experience low fertility rates. In comparison, countries such as France, UK, Sweden, Denmark and Belgium have rather higher fertility rates. Since none of the European countries reaches replacement level of 2.1 children per women, European societies face a decline in their total population and the population composition is changing. Reasons for a rising fertility are growing wealth (first leading to a decrease in fertility and later to a slight rise), cultural factors and social conditions. There is for example a strong correlation between fertility and the provision of childcare (EC, 2010, p. 68). Policies affecting child and family planning are in general suspected to have a strong influence on the fertility rate (Bick, 2011, p. 33).

¹ In other parts of the world, other determinants may have more influence.

Table 1: Total fertility rate per country (countries sorted by 2009 rates)

	1980	1990	2000	2003	2009
HU	1.91	1.87	1.32	1.27	1.32
DE			1.38	1.34	1.36
AT	1.65	1.46	1.36	1.38	1.39
ES	2.20	1.36	1.23	1.31	1.40
PL		2.06	1.35	1.22	1.40
IT	1.64	1.33	1.26	1.29	1.42
CZ	2.08	1.90	1.14	1.18	1.49
NL	1.60	1.62	1.72	1.75	1.79
BE	1.68	1.61	1.67	1.66	1.84
DK	1.55	1.67	1.77	1.76	1.84
SE	1.68	2.13	1.54	1.71	1.94
UK	1.90	1.83	1.64	1.71	1.96
FR	1.95	1.78	1.87	1.87	1.98
EU-27				1.47	1.60

Source: EC (2010, p. 26)

2.1.2 Life expectancy and longevity

People are living significantly longer in all European countries. This is reflected in an increase in life expectancy as can be seen in Table 2. Yet, there is large heterogeneity among the countries. While life expectancy for men is rather low in Lithuania with 63.1, men in Sweden have a life expectancy of 79.4 years. There is a significant gender difference to women's advantage. The lowest life expectancy for women is in Romania (77.4 years) and the highest in France (85 years). The gender difference in life expectancy varies by country between a difference under 5 years and up to 11 years (EC, 2010, p. 32).

Table 2: Life expectancy (average remaining years) per age and year in Europe

AGE/TIME	2002	2003	2004	2005	2006	2007	2008
1 year	77.2	77.2	77.8	77.9	78.3	78.5	78.8
20 years	58.5	58.5	59.1	59.2	59.6	59.8	60.0
40 years	39.3	39.3	39.9	39.9	40.3	40.5	40.7
65 years	17.9	17.8	18.4	18.4	18.8	18.9	19.1
80 years	8.1	8.0	8.4	8.4	8.8	8.8	8.9

 Source: http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database [20.12.2011]

Life expectancy does not only vary by country and gender, but also with level of education and other socio-economic factors.

A common indicator of the age structure of the population is the “(old) age dependency ratio” (demonstrated in Figure 1). This indicator shows the ratio between the number of older people (65+) and people in the working-age (15-64). The use of this term ‘dependency ratio’ should be discouraged though, as older people contribute to society in many ways, including a proportion continuing to work, a significant degree of inter-generational transfers to younger generations, as well as providing other support to younger generations.

In 1990, there were five persons in working-age per person aged 65 years or over. Twenty years later, there were only four persons in working age per older person (Eurostat, 2011). The UN forecasts this ratio to decrease to below two working aged persons per one older person by 2050 (UN, 2012, p. 20).

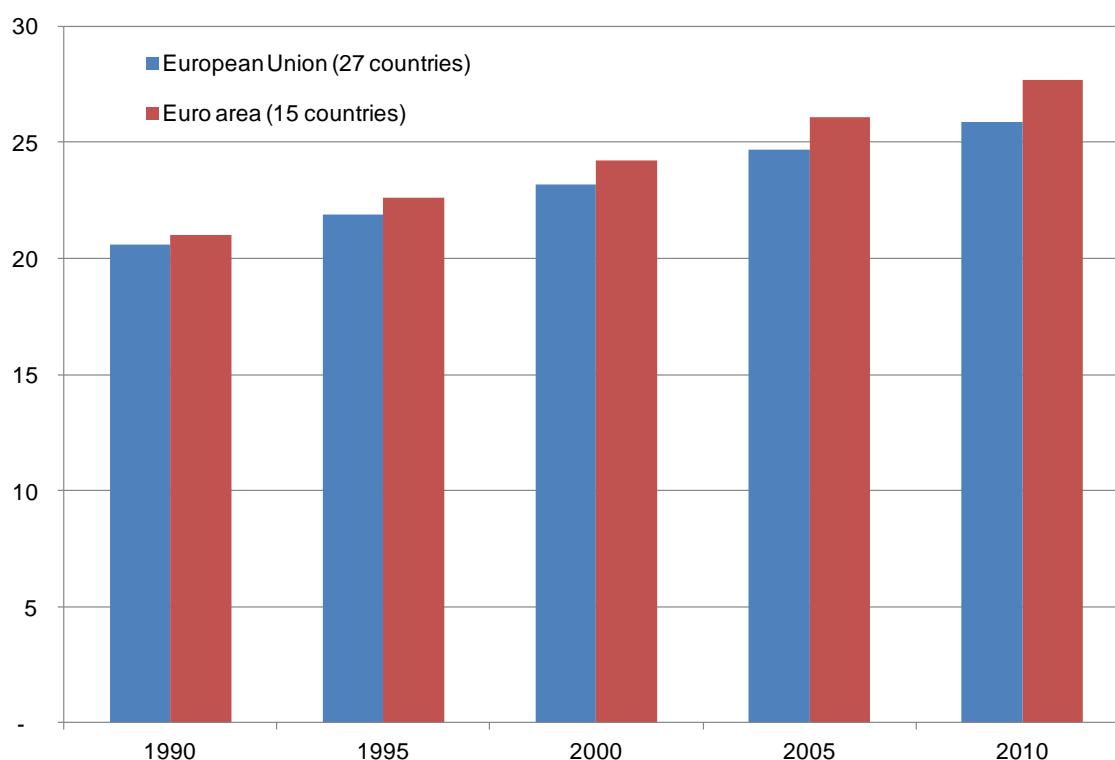


Figure 1: Age dependency ratio from 1990 to 2010; source: Eurostat (2011)

2.1.3 Migration

Migration² in Europe is most often demonstrated as migration flows of European citizens and non-European citizens either within one country or between countries. Between 2004 and 2008 immigration to European countries varied between 3 and 4 million people with a peak in 2007, whereas migration here includes migration within European countries (EC, 2010, p. 40).

49% of all immigrants to Europe in 2008 were citizens of countries outside the EU. Re-immigration of nationals made nearly 15% of all immigration and another 36% of immigration were citizens of other European member states (EC, 2010, p. 41).

EC uses an indicator called HDI³ to describe the origin of migrants. 93.6% of all immigrants to the EU are arriving from countries which are defined as either medium or highly developed. Only 6.3% of all immigrants come from countries defined as less developed by the HDI⁴.

Migration plays an important role in connection with population's age composition in Europe. As shown in Figure 2, the age structure of immigrants differs from the age structure of the EU population. Immigrants are in general younger (mainly in working-age) than the European population on average.

Especially in the decades from the 1960s onwards, immigration has been a vital factor not only with regard to the necessary labour force in the post-war period but also in view of the general economic situation of the receiving countries and has since been a substantial factor for economic growth and development (Boswell, 2005, pp. 2).

The role of migration processes for European countries has had a significant effect on the population development in Europe especially with regard to national population developments in the mid 19th century. Immigration to European countries allowed for a compensation of the rapidly decreasing fertility in central European countries (Boswell, 2005, pp. 133). At the beginning of the 20th century most European countries were still having population growth due to international immigration with only

² The definition of the term migration differs between European countries and therefore measurement differs as well. In general all countries reporting to Eurostat are asked to follow the Recommendations on Statistics of International Migration (UN, 1998) where an international migrant is defined as: "any person who changes his or her country of usual residence." (UN, 1998, p. 17). The term migration usually refers either to immigration or emigration or both, often emigration subtracted from immigration – the so called net migration.

³ UNDP (2012): human development index measured by life expectancy at birth, mean years of schooling, expected years of schooling and gross national income per capita.

⁴ Coming from a country with a low HDI does not necessarily mean that migrants are not well educated and well off in general. It is likely that many of those arriving from low HDI countries are skilled labour, considering the EU law restrictions, where member states seem to have a tendency to accept mainly work related migration of skilled labour.

small percentages stemming from other European countries (Malmberg, 2006, pp. 134). Projections in view of the population development are forecasting a decrease in population due to migration processes not being able to compensate for the declines of the fertility rates (Malmberg, 2006, pp. 134).

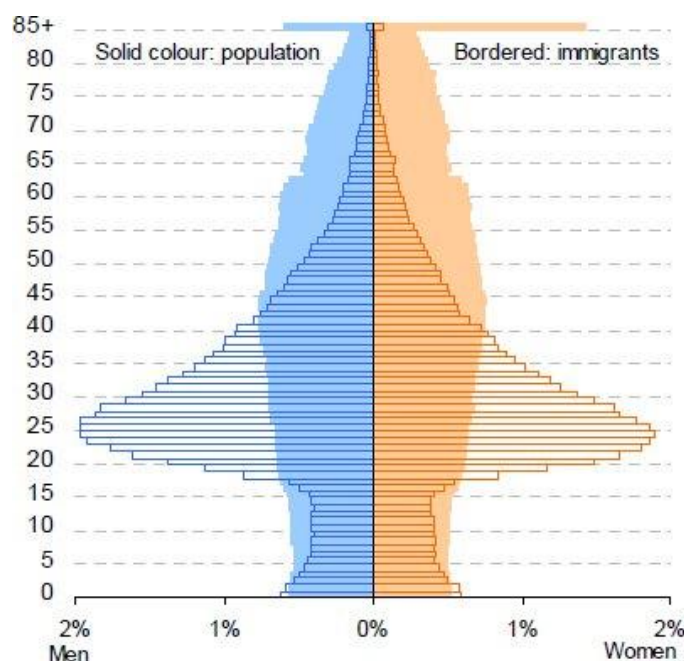


Figure 2: Age structure of the population on 1 January 2009 and of immigrants 2008, EU-27 (excluding BE, EL, CY, RO, UK); Source: EC, 2010 (p. 40)

The main effects of migration are represented in the age groups between 20 and 45 years of age (Vasileva, 2010, p.1). The different flows of immigration to European countries in two different waves (the first after 1945 to about 1970 and the second from the 1970s up until today), can be characterised by labour migration and the consequent reunification of families in the second wave (which lead to a positive migration rate in most European countries in the late 20th century (Malmberg, 2006, pp.130). Migration has a significant effect on the multi-ethnic character of the ageing populations in Europe. Today, the migration processes that have been vital for European countries are also subject to discussion in the fields of the effects of the ageing European populations especially in regard to welfare systems, including pension and health care.

2.2 Older people's socio-economic situation

In the following sections the socio-economic situation of the older population Europe is described. The references to general statistics and comparisons to younger age groups are based on data from the European Social Survey (ESS, 2010)⁵.

2.2.1 Gender, marital status and place of residence

While in the younger age groups about half of the population is male and half female, the majority of older persons is female. In the population aged 80 and older, the share of men is under 40%. Many older persons are widowed, women more often so than men. Only a minority of older persons is divorced. According to ESS data, proportions of persons living in an urban or rural area do not seem to change with age (see Table 3).

⁵ Tables 3, 5 and 6 show data for five age groups for different variables. The sample for this calculation includes 38.902 persons which lead to quite valid data.

Table 3: Gender, marital status and place of residence by age groups in percent

	Age in years					
	0 - 29	30 - 59	60 - 69	70 - 79	80 +	Total
<i>Gender</i>						
Male	49.3%	46.9%	46.5%	44.1%	38.0%	46.6%
Female	50.7%	53.1%	53.5%	55.9%	62.0%	53.4%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
<i>Legal marital status</i>						
Legally married	11.8%	60.9%	65.7%	54.2%	34.5%	49.9%
In a legally registered civil union	0.8%	1.6%	0.4%	0.4%	0.2%	1.0%
Legally separated	0.2%	1.1%	0.4%	0.2%	0.2%	0.7%
Legally divorced/civil union dissolved	1.2%	13.1%	13.3%	7.5%	3.8%	9.7%
Widowed/civil partner died	0.1%	2.7%	14.8%	33.5%	55.7%	9.8%
None of these	86.0%	20.7%	5.4%	4.2%	5.6%	28.8%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
<i>Place of residence</i>						
Urban	68.4%	65.0%	62.7%	64.3%	64.4%	65.2%
Rural	31.6%	35.0%	37.3%	35.7%	35.6%	34.8%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: ESS (2010), own calculation

2.2.2 Household and family structure

Household structure differs greatly throughout Europe. Culture, social spending, housing prices, and poverty, for example, influence the possibilities and limitations on how and with whom people live. Iacovou and Skew (2010) differentiated between four regions in Europe, yet noting that boundaries between those categories cannot be strictly applied on all European Countries. ‘Nordic’ countries include Sweden, Denmark, Finland and the Netherlands, the ‘North-Western’ cluster includes the U.K., France, Germany, Austria, Belgium, Luxembourg and Ireland. ‘Southern European’ countries are Italy, Spain, Portugal, Greece and Cyprus, whereas the last group, named ‘Eastern’ includes Czech Republic, Hungary, Estonia, Latvia, Lithuania, Slovenia, Slovakia and Poland. The highest share in single-adult households are found in Nordic countries, whereas the lowest share is found in southern countries which is in both cases explained by high or low divorce rates and the probability of cohabiting parents and (grand)children. Furthermore, Nordic countries display long phases of independent living ranging from early leaving of the parents’ house to a long phase of independent living in older ages. On the other hand, Southern European countries have larger household sizes with a low share of people not being married but cohabiting, children leaving their parents’ home rather later and older people often cohabiting with their children.

The least numbers of households where only couples reside are found in the Eastern parts of Europe, whereas single parent households (one parent, child or children) are most often found in the U.K., Finland, the Baltic states, Sweden and Ireland and least often in Southern Europe plus Poland, Slovakia and Slovenia (Iacovou & Skew, 2010, p. 12).

Table 4 shows ESS data on the distribution of men and women aged more than 65 years in different living arrangements in private households (nursing institutions and so on are not represented in the data).

For all European countries, women are more likely to live alone or with other people than a spouse. This can be explained by the gender difference in life expectancy as well as through cultural patterns of separation and divorce (Iacovou & Skew, 2011, p. 483). In North-Western and Scandinavian parts of Europe, older people mostly live with their spouse or alone and only very few people live together with other people, such as their children or grandchildren. For example in Germany, only 3.8% of all women live with people other than a spouse, whereas this figure is 25.7% in Spain and up to 36.5% in Latvia (Iacovou & Skew, 2010, p. 482). This can partly be explained by cultural factors; multigenerational families are more common in the eastern and southern countries. Other factors play a role, too. Isengard and Szydlik (2012) found that intergenerational co-residence often appears to be a response to economic insecurities at both individual and societal levels.

Table 4: Living arrangements of people aged 65+ in 2007, mean percentages

	Men aged 65+			Women aged 65+		
	Living with a partner	Living with just a partner (of all those living with a partner)	Living alone (of all those living without a partner)	Living with a partner	Living with just a partner (of all those living with a partner)	Living alone (of all those living without a partner)
Nordic	74.9	94.9	92.2	46.0	96.9	94.4
North-Western	73.6	89.5	88.5	48.5	93.0	86.9
Southern	79.3	64.4	64.8	44.7	70.4	61.2
New Member States	73.7	69.0	65.2	33.6	73.4	59.8
EU-15	75.6	81.3	82.2	47	85.7	78.1
EU-27	75.3	79.4	79.3	44.4	83.9	73.9

Source: Iacovou & Skew (2011, p. 482)

While intergenerational housing arrangements are in general less common, intergenerational activities have increased with time as a consequence of longevity. Grandparents and grandchildren are sharing a longer period of their lives and grandparents are ageing with better functionality than previous cohorts. Consequently, grandparents are often a significant source of informal child care (Hank &

Buber, 2009; Igel & Szydlik, 2011). Igel and Szydlik (ibid.) found strong involvement of grandparents in their grandchildren's care across all European countries, but also significant variations in the occurrence and intensity of grandchild care according to different female employment regimes and public investments in childcare infrastructures.

2.2.3 Income

The economic conditions of older people are a major social and policy interest, and financial well-being is a key item to understand older people's life conditions and lifestyles (including access to transport). Financial well-being varies considerably across European countries among individuals aged over 65, not only according to differences in income, but also differences in wealth and indebtedness (Christelis, Jappelli, Paccagnella & Weber, 2009). National differences in poverty among European countries have been widely studied and the previously demonstrated North-South difference has become less pronounced. In addition, Vignoli and De Santis (2010) have studied intra-country regional poverty differences in old age and showed that economic difficulties appear also significantly influenced by the specific context of residence.

In Europe, the majority of older persons get their income in form of pensions. With regard to coping with the present income, age differences are not very pronounced when looking at average values (see Table 5).

Table 5: Main source of household income and feeling about household's income nowadays by age groups in percent

	Age in years					
	0 - 29	30 - 59	60 - 69	70 - 79	80 +	Total
<i>Main source of household income</i>						
Wages or salaries	80.7%	77.8%	27.5%	6.5%	5.3%	59.5%
Income from self-employment	4.7%	7.3%	3.5%	0.9%	0.7%	5.2%
Income from farming	0.9%	1.2%	0.7%	0.3%	0.2%	0.9%
Pensions	2.3%	6.2%	63.7%	89.3%	90.7%	27.3%
Unemployment/redundancy benefit	2.6%	2.8%	1.2%	0.1%	0.2%	2.1%
Any other social benefits or grants	5.0%	3.2%	2.0%	1.9%	2.3%	3.2%
Income from investments, savings ...	0.2%	0.4%	0.7%	0.8%	0.2%	0.5%
Income from other sources	3.7%	1.1%	0.6%	0.2%	0.4%	1.4%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
<i>Feeling about household's income nowadays</i>						
Living comfortably on present income	30.9%	27.7%	27.0%	23.1%	25.1%	27.6%
Coping on present income	45.4%	43.7%	43.9%	44.0%	45.5%	44.2%
Difficult on present income	17.5%	19.6%	19.1%	21.8%	19.0%	19.3%
Very difficult on present income	6.3%	9.0%	10.0%	11.1%	10.4%	8.9%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: ESS (2010), own calculation

2.2.4 Health and social activities

The estimation of health gives a rather consistent picture of differences between age groups. Subjective health declines with age (see Table 6).

Table 6: Subjective general health and social activities by age groups in percent

	Age in years					
	0 - 29	30 - 59	60 - 69	70 - 79	80 +	Total
<i>Subjective general health</i>						
very good	41.8%	21.4%	10.4%	7.1%	5.7%	21.5%
good	42.6%	46.3%	35.1%	27.6%	22.9%	40.7%
fair	13.7%	25.6%	40.7%	42.4%	41.6%	28.1%
bad	1.7%	5.6%	11.4%	19.0%	24.0%	8.0%
very bad	.2%	1.1%	2.4%	4.0%	5.8%	1.6%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
<i>Social activities</i>						
not often	10.2%	22.8%	25.5%	29.6%	32.5%	22.4%
often	89.8%	77.2%	74.5%	70.4%	67.5%	77.6%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: ESS (2010), own calculation

Analysis of the SHARE⁶ data showed considerable gender differences and inequalities on health (see e.g. Rueda, Artazcoz & Navarro, 2008). Crimmins, Kim and Solé-Auró (2011) examined and compared gender differences for people aged 50 years and older in several countries (11 European countries, England and the USA) on the basis of data coming from three different surveys (SHARE, ELSA, HRS). They showed that women in all countries are more likely than men to have disabling, non-fatal conditions including functioning problems, instrumental activities of daily living (IADL) difficulties, arthritis and depressive symptoms; self-reported heart disease is more common among men. These differences remain when controlling for smoking behaviour and weight. Self-reported hypertension is generally more common among women; stroke and diabetes do not show consistent sex differences. While subjective assessment of health is poorer among women, this is not true when indicators of functioning, disability and diseases are controlled.

The social activities tend to decline somewhat with advancing age (see Table 6). Older persons' social activities take place in family context and in other networks of social participation (Kohli, Hank & Kunemund, 2009). There has been found a positive link between quality of life and participation in socially productive activities (like volunteering) in early old age (Siegrist & Wahrendorf, 2009). Here, the role of transportation and possibility for out-of-home mobility is crucial. As described in the following chapter, mobility is an important contributor to well-being and quality of life in old age.

⁶ SHARE, the Survey of Health, Ageing and Retirement in Europe (Börsch-Supan et al. 2005, 2008; Börsch-Supan, Hank & Jürges, 2005).

3 Ageing and transport

This chapter provides a concise state-of-the-art review of what is known about older road users. For more detailed review, we refer to the several recent studies covering this topic, either with a focus on older drivers (Box, Gandolfi & Mitchell, 2010; Eby & Molnar, 2012; Hakamies-Blomqvist, Sirén & Davidse, 2004), older people and public transport (Fiedler, 2007) or older people's mobility in general (Whelan, Langford, Oxley, Koppel & Charlton, 2006). Here, the aim is to focus on topics regarded as most relevant in the context of the CONSOL project.

3.1 *Mobility and quality of life*

Previous research has shown that mobility and the ability to leave the home are essential aspects of the quality of life of older persons (Farquhar, 1995), and often connected to psychological well-being, independence, and the sense of being empowered in old age (e.g. Bonnel, 1999; Fonda, Wallace & Herzog, 2001; Gabriel & Bowling, 2004; Marottoli et al., 1997; Ragland, Satariano & McLeod, 2005). An individual's ability to use the transportation system has also long been defined as one of the seven important areas in the Instrumental Activities of Daily Living (IADL) of the elderly (Fillenbaum, 1985; Lawton & Brody, 1969), and mobility is often a precondition for the individual to be engaged with her/his environment, which is an important cornerstone of what has been defined as *successful ageing* (Rowe & Kahn, 1987). Increasing level of mobility (Jansen et al., 2001) and participation in social and physical activities (Banister & Bowling, 2004; Gagliardi, Marcellini, Papa, Giuli & Mollenkopf, 2010) have been demonstrated to be associated with higher life satisfaction.

While activity frequency is determined by physical health and the size of the social network (e.g. Jansen et al., 2001; Haustein, 2011; Scheiner, 2006b; Smith & Sylvestre, 2001) – variables that directly affect well-being – frequency of activities by itself has been found to be a significant predictor of well-being even if other factors, such as health status and living together with a partner, are controlled for (Scheiner, 2004a).

Spinney, Scott and Newbold (2009) quantified the impacts of mobility on quality of life for non-working elderly Canadians. Based on time spent on different activities, they differentiated between psychological benefits, exercise benefits, and community benefits of transport mobility. They showed that increasing exposure to mobility related benefits were positively associated with various quality of life domains. Exposure to psychological benefits of mobility in particular was associated with positive outcomes in health and life satisfaction.

While there is a consensus on the positive effect of mobility on quality of life in old age, the question to what extent car use is a precondition for mobility-related well-being in old age is more debated. On the one hand, car access has been found to be associated with better health and well-being (Banister & Bowling, 2004; Ellaway, Macintyre, Hiscock & Kearns, 2003; Macintyre, Hiscock, Kearns & Ellaway, 2001). It enables older people with physical limitations to still live independently and participate in normal daily activities, and as such the car can act as a compensation tool for functional limitations (Siren & Hakamies-Blomqvist, 2004; 2009). According to Köpke, Deubel, Engeln and Schlag (1999) car availability and car use are related to a positive self-perception of older persons and several studies have found driving cessation to be a risk factor for a depressive development (e.g. Fonda et al., 2001; Marottoli et al., 1997). Mollenkopf and Flaschenträger (2001) show that car availability has a positive impact on the satisfaction with the possibilities of using one's spare time.

However, the effects might vary between drivers (and ex-drivers) and those who have never driven. Scheiner (2006b) showed that there is no significant impact of car ownership on fulfilment of leisure needs nor on leisure satisfaction if other factors are controlled for. He argues "that car availability is not a cause for mobility, but rather a result of a specific life situation and way of life (...) associated with a specific type of mobility" (p. 151). Haustein (2011) showed that those whose travel mode choice is mostly driven by individual choices and preferences are more satisfied with their mobility options and exercise more leisure activities compared to people who either depend on the private car or on public transport. The importance of car for older people's well-being is also partly dependent on spatial factors; in rural areas the car is more important for mobility (Mollenkopf, 2002).

3.2 Mobility behaviour of older persons

3.2.1 Travel and mobility patterns

Number of trips, travel times and distances

On average, older people travel less than younger persons in terms of trips per day, distance and travel time (e.g. BFS & ARE, 2007; DTU, 2011; OECD, 2001; INFAS & DLR, 2010; O'Fallon & Sullivan, 2009; TØI, 2011). The most marked decrease in trip number and travel time takes place after the age of 75 as Figure 3 illustrates with data from Germany as an example. Regarding distances, there is a peak at the age of 30-39 years before the travel distances decrease more continuously until high age. The general trend of decreasing travel activity with age is rather universal, but the specific parameters differ somewhat between European countries, indicating for example, differences in licence renewal

policies⁷, socio-economic or other background variables. A more comprehensive description of older people's mobility behaviour in different European countries can be found in CONSOL WP2 report "Mobility patterns in the ageing societies".

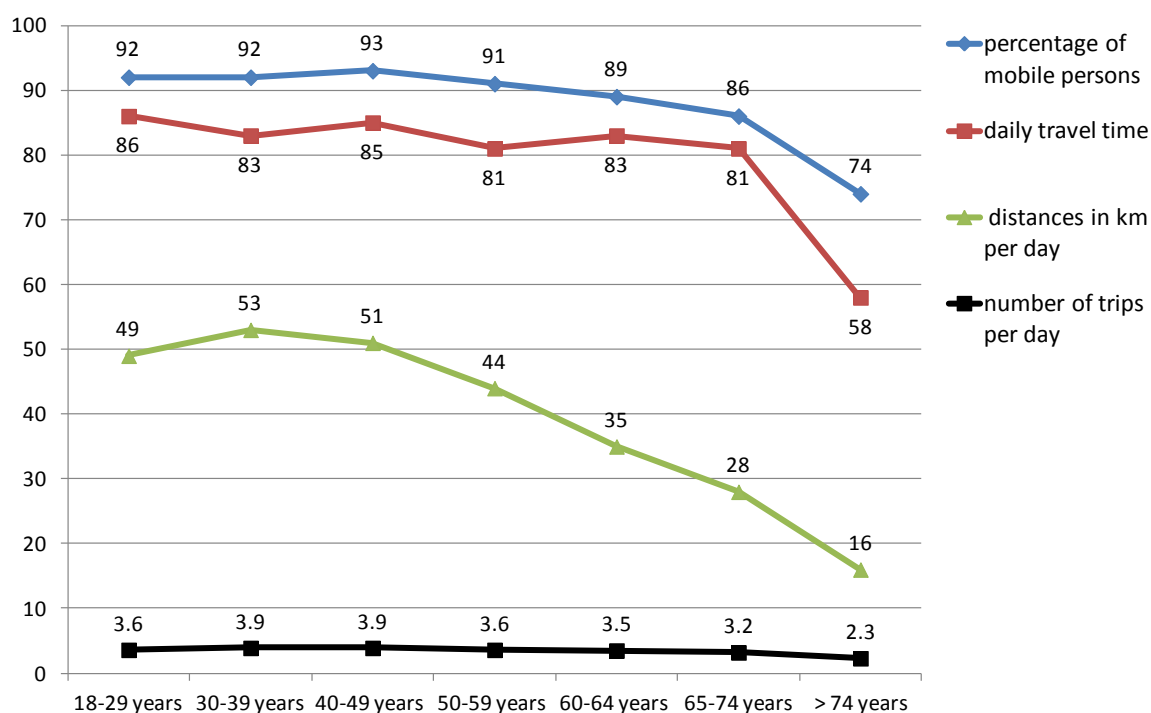


Figure 3: Mobility parameters in Germany 2008; Source: INFAS & DLR, 2010

Modal choices

According to the OECD (2001, p. 32) in Europe about half of older people's trips are made by private car. With regard to public transport, the picture differs more significantly between different countries (e.g. higher use in Scandinavia and Great Britain, lower in the Netherlands). Trips on foot show a U-shaped curve with middle-aged people walking less than younger and older people. Depending on the country, 30-50% of trips are made on foot. Finally, cycling is of minor relevance as a transport mode for older people, except in Denmark and the Netherlands. Compared to other adult age groups, older people have a higher share in walking and public transport use and drive a car less frequently (e.g. INFAS & DLR, 2010; OECD, 2001; TØI, 2011).

Comparing travel data of older people (62-95 y.) from Austria, the Netherlands and Sweden, Bell et al. (2010) found that older Austrians' preferred mode is walking, whereas older people in Sweden and the

⁷ Like Belgium, France, and Austria, Germany issues licenses of unlimited validity.

Netherlands (to a lower extent) prefer the private car. In the Netherlands cycling is in second position, while it plays only a minor role in the other two countries.

Trip purposes

Concerning trip purposes, we observe an increase of trips of older people belonging to the social/leisure category in recent years (e.g. Arentze, Timmermanns, Jorritsma, Kalter & Schoemakers, 2008; Hjorthol, Levin & Siren, 2010; INFAS & DLR, 2010; van den Berg, Arentze & Timmermanns, 2011). However, with increasing old age those fewer trips become more focused on daily supply and thus a higher share of the older old's trips is made for shopping or private arrangements (INFAS & DLR, 2010; TØI, 2011).

Car travel

Research has indicated a notable increase in licensing rates and car access for the older population during recent decades (e.g. Hjorthol et al., 2010; Ottman, 2010; Rees & Lyth, 2004). Until the year 2030 further increases in licence rates are expected, as Table 7 shows, for different European countries (OECD, 2001). Even though holding a licence does not necessarily imply active driving, the travel data show that older people today are making more trips and are more mobile compared to earlier cohorts of older people (Banister & Bowling, 2004; Dejoux, Bussiere, Madre & Armoogum, 2010; INFAS & DLR, 2010; O'Fallon & Sullivan, 2009; Rosenbloom, 2001), especially with regard to car trips (e.g. INFAS & DLR, 2010; Newbold, Scott, Spinney, Kanaroglou & Páez, 2005; OECD, 2001; O'Fallon & Sullivan, 2009; Rees & Lyth, 2004; Tacken, 1998). Concerning kilometres travelled by car (driver and passenger) per day, people who were aged 40 to 49 in the mid-1970's almost maintained their level of car travel when aged 60 to 69. Another ten years later (aged 70+), there is a reduction of a mere 5 km per day (from about 25 km to 20 km per day (results from Germany & UK; Zumkeller, 2011).

The increasing mobility of older people is explained by attitudinal effects (raised mobility needs, more active lifestyles), improved physical possibilities (fitness and health conditions), as well as cohort effects (INFAS & DLR, 2010). The cohort effect refers to the effects of being born at a specific time in history connected with similar socialisation influences and experiences.

Table 7: Driving licence rates for older people, projected to 2030 for selected European countries

	Percentage of licensed drivers aged 65+ in 2000	Percentage of licensed drivers aged 65+ in 2030	Percentage increase in licensed drivers aged 65+
Finland	14.9	26.7	79
France	16.1	25.8	60
Netherlands	13.7	26.5	93
Norway	15.3	23.5	53
Spain	16.8	26.1	55
Sweden	17.2	24.1	40
United Kingdom	15.7	23.5	49

Source: OECD (2001)

Unfulfilled mobility needs

When looking at older people's mobility behaviour it is important not only to focus on the trips older people make, but also consider which desired trips remain unrealised. According to the German study Frame (Scheiner, 2006a) about half of older people report unfulfilled mobility wishes, especially with regard to cultural events, holidays or sporting activities. The most important reasons provided by the participants for not taking part in an activity were health, not wanting to do an activity alone, and public transport related reasons (Scheiner, 2006a). Variables related to unmet activity wishes were bad health, employment, and gender (i.e. women experience more unmet activity wishes). In contrast, the existence of unfulfilled activity wishes was not related to other conditions, such as car availability, the spatial context, or having a partner or not (Scheiner, 2006a,b). In a Finnish study (Siren & Hakamies-Blomqvist, 2004) it was also especially leisure trips that were most often unrealised, in the first place visiting friends. In this study women reported a higher level of unfulfilled travel needs than men as well as those living in rural areas, those living alone, those without a driving licence, and the oldest old (80+). Also a recent Norwegian study (Hjorthol, 2013) found that visiting friends and family – together with going for a walk – were the activities older people missed most, women more than men. The unmet need of visiting others was significantly related to health, age, having a driving licence and access to a car.

Factors found to affect travel activity besides individual characteristics (such as health or socio economic characteristics) include accessibility to either public or private transport (e.g. Paez, Scott, Potoglou, Kanaroglou & Newbold, 2007; Smith & Sylvestre, 2001) as well as neighbourhood accessibility in general, which may reduce the level of car use and dependency (Cao, Handy & Mokhtarian, 2007; Haustein, 2011).

3.2.2 Older persons' experiences in traffic

Transport related attitudes, needs and preferences

Several studies have looked into older people's specific attitudes, needs and preferences concerning the transport system. The results vary considerably between studies. In some, older people have been found to value most the aspects of safety and security in mobility (Flade, 2002; Transek, 2005). These qualities are followed by getting exercise and avoiding pollution when travelling (see Figure 4). All these aspects are evaluated as more important by older people (> 65 y.) than by young people (< 30 y.), for whom time-related aspects are more relevant. Independence is considered as an important quality by both age groups.

In contrast, Scheiner (2004b) found the most important criteria for older people's choice of a transport mode being convenience (mentioned by 20%), speed (15%) and independence (14%), while safety only follows in the fourth position. The difference to Flade's results can be explained by different methods (rating given statements vs. open question) as well as with a younger target group in Scheiner's study (aged 60 and above with about 10% still working), which explains the higher importance of time-related aspects.

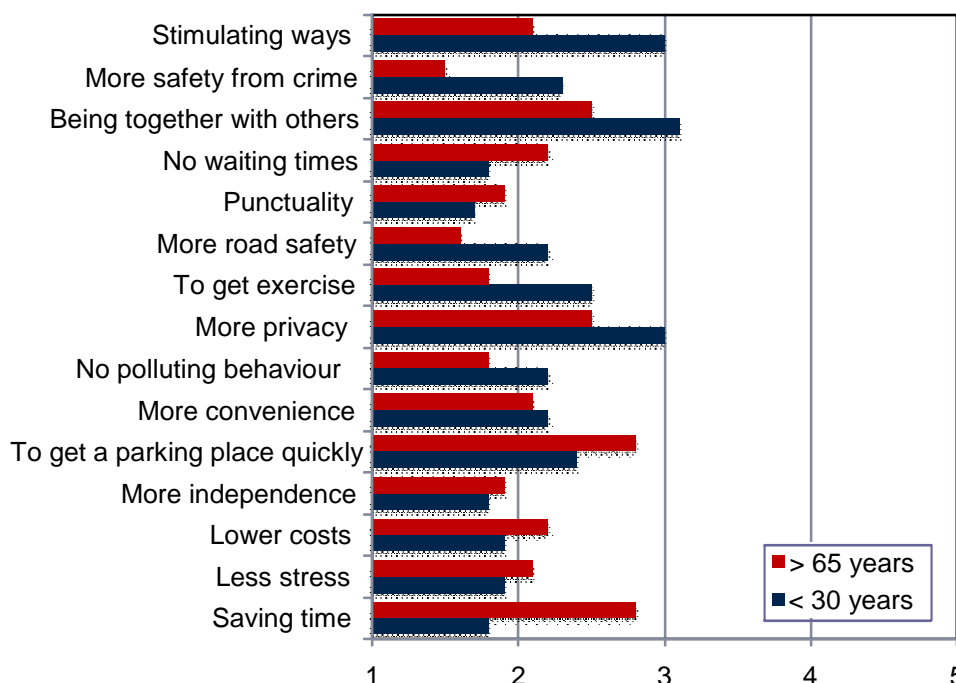


Figure 4: Evaluation of the importance of different mobility criteria
 1= very important; 5 = not important at all; source: Flade (2002)

Mollenkopf and Flaschenträger (2001) found seniors regarding heavy traffic and the aggressive, ruthless driving style of many car drivers and cyclists as the main problems in road traffic. Similarly, in a qualitative study, Siren and Kjær (2011) found that older drivers constructed risk in traffic as something external, often originating to the other road users' reckless behaviour. In a study by Risser, Haindl and Ståhl (2010) amongst the five highest ranked barriers to mobility of older road users, three were related to behaviour of other road users with "inconsiderate car drivers" as the most important one. Ernst (1999) found that seniors often wish other road users to change their behaviour, especially in the relation between pedestrians and car drivers and pedestrians and cyclists. These concerns of older road users are realistic: the safety of unprotected older road users is worse than in other road user groups.

Perceived safety and security

As car drivers, older persons have been found to perceive certain driving situations and conditions as dangerous. These include driving in specific weather conditions (e.g. fog, rain, storm), when feeling physically unwell or excited, driving in high traffic density, driving on specific road types (e.g. motorways/highways), road characteristics (e.g. signage, traffic lights, curves, roundabouts), and others' driving behaviour (e.g. people driving too close, tailgating) (Jansen et al. 2001; Sullivan, Smith, Horswill & Lurie-Beck, 2011).

Older cyclists report feeling uncomfortable in heavy traffic and on busy main roads and many older cyclists avoid heavy traffic and darkness. Discomfort and fear of not coping in traffic tend to increase with deteriorating health. However, the majority of seniors only seldom report feeling insecure when cycling (Steffens, Pfeiffer & Schreiber, 1999). Most of the seniors, who do not want to use a bicycle, cite health as the main reason. Other frequent reasons are fear of falling off the bicycle or fear resulting from high traffic density (Janoška, Bíl & Kubeček, 2011).

Generally, fear of having an accident in traffic is less pronounced than fears of becoming a victim of crime (Ernst, 1999). Fear of crime is considered to be a relevant factor restricting the mobility behaviour of older people and is regarded to be a key barrier towards public transport use (Knight, Dixon, Warrener & Webster, 2007). Several studies indicate that older people perceive a greater danger in public space than younger people and attach greater importance to safety from crime (e.g. Flade, 2002; Scheiner & Holz-Rau, 2002). Perceived danger has a negative impact on the experience of public transport and older transport users regard security to be a relevant aspect of the attractiveness of mobility services (Engeln & Schlag, 2001; Megel, 2002). However, perceived danger does not reduce older people's number of leisure time activities (Haustein & Kemming, 2008). Research has found a weak correlation between travel mode choice and perceived danger, which may indicate that trips in situations being deemed dangerous (e.g. alone in darkness) are either shifted to some other point of time or made when accompanied (Haustein, 2011; Haustein & Kemming, 2008). There is a large difference in the safety ratings of daytime and night-time activities. While daytime

activities are perceived to be safe, 42% of older people never go out during the night (Banister & Bowling, 2004).

With increasing age, the fear of falling, especially on poorly maintained pavements, also becomes a relevant factor in restricting older people's mobility. The fear has been found to be related to a loss of confidence leading to less physical activity, avoidance of activities, and decreased social contact (Scheffer, Schuurmans, van Dijk, van der Hooft, & Rooij, 2008). In this context, the state of the pavements is a very important aspect: In a Swedish study older people reported insufficient prevention of slippery pedestrian walkways (including poor snow clearance) as the most important risk factor in their outdoor environment (Ståhl, Carlsson, Hovbrandt & Iwarsson, 2008).

Improving the transport system based on older persons' experiences

Various studies suggest improvements in the transport system, based on the seniors' mobility needs and preferences. Transek report (2005) points out that older people's stated preferences favour measures to reduce traffic accidents rather than measures to improve accessibility (and thereby travel time) and the environment. Mollenkopf and Flaschenträger (2001) found the wish for more politeness and consideration ranked highest by the older persons, followed by the adjustment of buses to the needs of seniors. Also the increase of road safety and security in public space was regarded as important. Risser et al. (2010) asked seniors and experts to assess how urgent certain measures were to be implemented to improve senior's mobility. Both groups suggested enforcing vehicle speeds as the most important measure, followed by bringing public transport vehicles into an appropriate standard. While seniors asked for measures to support the sense of safety and security in public space in the third place, experts attached less importance to this aspect. Another discrepancy between seniors and experts' opinion was found regarding the reduction of ticket cost, which was ranked in 6th position by seniors but only in the 12th position by experts.

Asking older car drivers for their requests regarding public transport, they primarily demand a reduction of travel costs, safety from crime and a simplification of ticket purchase. In contrast, comparably little importance is attached to the reduction of waiting time (Engeln & Schlag, 2001). In line with this, Su (2007) found a higher effect of travel costs compared to travel time on older people's mode choice.

3.3 Car driving in old age

3.3.1 Driving patterns

Older drivers differ somewhat from drivers in other age groups in terms of their driving behaviour, patterns and preferences. Older drivers have been found to (to a larger extent) choose not to drive in

certain conditions or environments, to avoid risk taking, to drive with lower speeds and to cover less mileage than younger and middle-aged drivers. In general, the behavioural patterns of older drivers contribute to a more safe driving culture, and if more widely replicated, could benefit the traffic safety of all generations.

Avoidance of driving situations

Older drivers have been found to avoid certain driving conditions such as rush hours, darkness, poor weather and road-surface conditions or driving in unfamiliar areas (e.g. Chipman, MacGregor, Smiley & Lee-Gosselin, 1993; D'Ambrosio, Donorfio, Coughlin, Mohyde & Meyer, 2008; Gwyther & Holland, 2012; Hakamies-Blomqvist, 1994a; Rabbitt, Carmichael, Jones & Holland, 1996; Rothe, 1990; Transek, 2005).

However, avoiding specific situations does not necessarily mean that the related activities are not conducted. Retired older people have a wider array of choices with regard to travel times and weather conditions and are thus often free to drive at day-time, avoid the rush hour and drive in better weather-conditions. When still working, one strategy reported by older drivers is to take a less direct, but less congested, route to work or work non-standard or flexi-hours in order to avoid the rush hour (Knight et al., 2007).

Driving style and risk taking

Besides the avoidance of specific situations older drivers often show a more defensive driving style, that is, they drive with lower average speeds (e.g. Chipman, MacGregor, Smiley & Lee-Gosselin, 1992) and keep a larger following distance (Rajalin, Hassel & Summala, 1997). Compared to middle-aged drivers, older drivers are also less likely to be engaged in certain distracting activities, such as adjusting in-vehicle equipment or using the mobile phone (Fofanova & Vollrath, 2012; McEvoy, Stevenson & Woodward, 2006). These findings might explain the comparably low risk of older drivers to cause an accident given the higher sensory and cognitive restrictions. Also literature from a psychometric perspective supports the findings that older drivers compensate for their limitations by behaving more cautiously, adapting their way of driving, and/or generating alternative behaviours (Monterde-i-Bort, 2004).

3.3.2 Self-regulation and behavioural compensation

Self-regulation of driving refers usually to the voluntary reduction or avoidance of certain (usually challenging or demanding) driving situations. As noted above, older drivers have been found to avoid certain driving conditions. The age-related changes in driving patterns are often referred to as self-regulatory driving and seen as a strategy to compensate for age-related decline and continue driving

safely in old age and thus prolong the period of independent safe mobility (e.g. Donorfio, Mohyde, Coughlin & D'Ambrosio, 2008).

Indeed, functional decline, and increasing cognitive and visual restrictions have been found to be associated with self-regulation of driving (Ball et al., 1998; Charlton et al., 2006; Holland & Rabbitt, 1992; Ross et al., 2009; Stutts, 1998). In addition, perceived own driving skill and perceived self-assessed driving-related processing speed and attention abilities have been found to play a role in avoiding and self regulating driving (Gabaude, Motak & Marquié, 2010; Gabaude, Marquié & Obriot-Claudel, 2010; Rimmö & Hakamies-Blomqvist, 2002). In addition, previous research indicate that driving-related discomfort functions as an indirect self-monitoring of driving ability and affects self-regulation of driving (Meng & Siren, 2012).

However, self-regulation does not seem exclusively to be a strategy to compensate for age-related decline. Research has also found that other factors affect self-regulation of driving among older drivers, such as age, gender, change in employment status (retirement), household income, the presence of other drivers in the household, confidence in their own driving, and having been involved in an accident (D'Ambrosio et al., 2008; Charlton, Oxley, Fildes, Oxley & Newstead, 2003; Charlton et al., 2006; Gwyther & Holland, 2012; Ragland, Satariano & MacLeod, 2004; Vance et al., 2006). Gender in particular seems to be associated with self-regulative behaviour. Women self-regulate more than men (Charlton et al., 2006; D'Ambrosio et al., 2008; Hakamies-Blomqvist & Wahlström, 1998; Molnar & Eby, 2008; Rimmö & Hakamies-Blomqvist, 2002) and gender has been found to have a greater effect on self-regulation than age and functional status (Kostyniuk & Molnar, 2008; Lang, Parkes & Fernandez-Medina, 2013).

3.3.3 Reducing and giving up driving

Reasons to reduce and give up driving

The main predictors of driving cessation are health conditions and certain social factors. General health status is strongly associated with driving cessation and the experienced health impairments are likely to result in modifying, reducing and eventually stopping driving (e.g. Dellinger, Sehgal, Sleet & Barrett-Connor, 2001; Persson, 1993; Siren, Hakamies-Blomqvist & Lindeman, 2004). The most common medical conditions predicting driving cessation include sensory problems, cognitive impairment, stroke, cardiovascular and other heart conditions, diabetes and physical mobility and activity problems, such as arthritis (Brayne et al., 2000; Campbell, Bush & Hale, 1993; Dellinger et al., 2001; Forrest, Bunker, Songer, Coben & Cauley, 1997; Hakamies-Blomqvist & Wahlström, 1998; Keeffe, Jin, Weih, McCarthy & Taylor, 2002; Lafont, Laumon, Helmer, Dartigues & Fabrigoule, 2008; Ragland et al., 2004; Scilley et al., 2002).

However, the strong association between health and driving cessation may be a somewhat biased finding since many studies have uncritically presumed medical conditions or deteriorated driving skills to be the major reason for stopping driving. For example, in a study by Persson (1993), eight out of ten potential reasons for driving cessation that the older subjects were asked to choose from were related to health or deterioration in driving ability. In a recent Danish study, people evaluated the importance of eight different motives for not renewing their licence, and health was rated as second important. The most important motive was that people simply did not want to drive anymore (Siren, Haustein & Meng, 2012). In a Swedish study (Transek, 2005) reasons for driving cessation were failing health (especially mentioned by men) and not having a car. In a study by Ragland et al. (2004) problems with eyesight was the leading cause to avoid or cease driving, followed by “no reason to drive”. Finally, in a study including older drivers from Finland, Germany and Italy, commonly stated reasons to reduce driving included being able to reach everything without a car, health reasons and too hectic traffic (Raitanen, Törmäkangas, Mollenkopf & Marcellini, 2003).

Social factors have been found to play a part in the decision to give up driving in addition to medical and health-related reasons. In Finland, Hakamies-Blomqvist and Wahlström (1998) found that over 30% of women and approximately 25% of men aged 70 who had stopped driving reported that the reason for doing so was that driving/ having a car was expensive. In a Danish study, financial reasons were rated as the third important reason (out of eight) for driving cessation (Siren et al., 2012). Chipman, Payne and McDonough (1998) found that elderly Canadians, aged 80 and over were likely not to drive if they lived in a large household (>3 persons) or alone, were widowed, or female, while those living in a two-person households, married or male were likely still to be driving. This is in line with other studies, which found that those who ceased driving were more likely to be unmarried, widowed or divorced and female (Braitman & Williams, 2011; Siren et al., 2004).

As the studies referred to above indicate, just as driving habits in general, also driving cessation is highly gendered. Women are more likely to give up driving earlier than men. The gender differences in driving cessation and driving reduction will be described in more detail in Chapter 4.2.

Social responsibilities are also a factor that might strongly influence the decision to continue driving. Drivers who are responsible for someone else’s transportation seem to be more likely to continue (Adler, Rottunda, Rasmussen & Kuskowski, 2000). Similarly, Bonnel (1999) found in her qualitative interview study that older women viewed driving cessation as significantly impairing their social activities, not least because it would prevent them from giving lifts to others. A Swedish qualitative study by Siren et al. (2004) indicated that using the car to carry out social responsibilities gave the car an important personal meaning among older women. Thus, especially for older women who drive, social responsibilities may be a major factor in the decision to keep on driving. However, in a regression analysis with other social as well as medical variables as predictors of driving cessation, the frequency of chauffeuring others did not become significant (Siren et al., 2012). Nevertheless, the overall frequency of car use was a significant predictor (Siren et al., 2012), indicating that an active

and extensive driving career generally delays driving cessation (e.g. Rabbitt et al., 1996). It could also be shown that people who feel less safe as a driver are more likely to give up driving as well as people who depend on others to leave home.

Consequences of driving cessation

With regard to consequences, driving cessation is likely to decrease both the mobility and the safety of the former drivers, since alternative travel options are often insufficient, unattractive, and less safe (OECD, 2001). Siren and Meng (2012) found that the implementation of screening older drivers for cognitive impairment did not change the number of older drivers involved in fatal accidents but was related to a higher number of unprotected older road users who were killed. This suggests that the screening process produced a modal shift among older persons from driving to unprotected, significantly less safe modes of transportation. A similar finding was made by Hakamies-Blomqvist, Johansson and Lundberg (1996).

Driving cessation reduces out-of-home mobility in general (Marottoli et al., 2000) and is associated with a decrease in experienced personal mobility options, as demonstrated in various studies using a qualitative approach (e.g. Bonnel, 1999; Taylor & Tripodes, 2001; Yassuda & Wilson, 1997). However, it has also been shown that the extent of the reduced mobility varies widely depending on access to alternative forms of transport, perceived ability to use them, and the previous knowledge and experience in using them in the past (Knight et al., 2007). Furthermore, qualitative studies have found driving cessation to be associated with experiences of identity loss (Eisenhandler, 1990), loss of independence (e.g. Adler & Rottunda, 2006; Burkhardt, Berger & McGavock, 1996) as well as overall depression, stress and feelings of isolation (Peel, Westmoreland & Steinberg, 2002).

In their epidemiological studies Marottoli et al. (1997) found an association between driving cessation and increased depressive symptoms. Fonda et al. (2001) also conducted a longitudinal study to examine how driving cessation and reduction contributed to increased depressive symptoms in older adults. They found that drivers who reduced or stopped driving had a higher risk of showing increased depressive symptoms, and that those who stopped had an even greater risk than those who reduced it. However, it has to be pointed out, that non-car drivers were not included in the study. In contrast, Ragland et al. (2005) compared the depressive status of "former drivers", "current drivers" as well as "never drivers" in a 3-year-longitudinal study. At baseline-level "former drivers" had the highest values and "current drivers" the lowest, whereas the "never drivers" lay in between. However, only the active drivers were questioned again after 3 years and those who ceased driving showed a higher level of depression than those who remained active drivers. Increased depression for former drivers was higher in men than in women. Windsor, Anstey, Butterworth, Luszcz & Andrews (2007) have found that the increase of depressive symptoms associated with driving cessation can partly be explained by a corresponding decrease in control beliefs.

A study by Edwards, Lunsman, Perkins, Rebok & Roth (2009) indicates that among older adults, driving cessation is accompanied by significant declines in physical and social functioning and general health declines more rapidly after driving cessation. Finally, in a US study driving cessation was found to increase the risk for entering long-term care institutions (Freeman, Gange, Muñoz & West, 2006).

All in all, the consequences of driving cessation seem to be negative throughout (cf. Oxley & Whelan, 2008). However, there is some uncertainty about the cause-effect-relationship and often it is impossible to determine if for example, reduced mobility and bad health are either cause or effect of driving cessation.

3.4 Safety of older road users

3.4.1 Defining the “safety problem” of older road users

Older road users have long been identified as a special group in terms of road safety. However, the understanding of the safety problems and issues of older road users has varied considerably throughout time (see e.g. Hakamies-Blomqvist & Peters, 2000). The WHO has recognized that the chief hazard to older road users relates to unprotected road users – pedestrians and cyclists (Hakamies-Blomqvist & O'Neill, 2004). Older drivers, on the other hand, have an enviable safety record, and the fact that this occurs in the face of increasing levels of age-related disease and disability which might affect driving ease and safety is a potent metaphor for the gains of ageing, whereby wisdom and strategic thinking compensate for these deficits (O'Neill, in press).

Unprotected road users

While older people are not a threat to other road users (e.g. Evans, 2000), they do have a higher risk of being hurt or killed in an accident themselves because of their higher frailty (Evans, 2000; Lafont, Amoros, Gadegbeku, Chiron & Laumon, 2008; Lafont, Gabaude, Paire-Ficout & Fabrigoule, 2010). In addition, the fact that older people more often use unprotected modes (esp. walking), increases their risk of being seriously injured or killed in an accident (Box et al., 2010; Statistisches Bundesamt, 2010). Compared to younger adults, mortality in road traffic accidents is more than doubled for older pedestrians (Martin, Hand, Trace & O'Neill, 2010). Relations between age and mortality risk have also been found in case of cycling (Bíl, Bílová & Müller, 2010). People above 65 years are the most at risk of death in bicycle to car accidents compared to other age groups in terms of the ratio of fatal injuries to the sum of serious and fatal injuries.

Another, as yet rather neglected risk factor for older road users, are non-collision injuries on buses. Here, standing passengers are more likely to be seriously injured than sitting passengers, and there

are more casualties when alighting the bus than when boarding (Kirk, Grant & Bird, 2003; Palacio, Tamburro, O'Neill & Simms, 2009).

The high risk of unprotected road users should potentially prompt significant actions, including traffic organization (Johansson & Leden, 2007), vehicle modification (Simms & O'Neill, 2006) and adaptation of technology such as pedestrian crossings (O'Neill, 2010a). In addition, poorly-conceived and inappropriate screening measures which serve to displace older drivers unnecessarily from their cars to become unprotected road users (Siren & Meng, 2012) should be strongly discouraged.

An evolving area of concern is that of single pedestrian accidents (Feypell, Methorst & Hughes, 2012), which are more common among older road users and in all likelihood affect significantly more older road users than any other form of accident. There is an urgent need for European traffic safety review of the causes and possible mechanisms for correcting these accidents.

Safe older drivers

Impairing perceptual abilities, memory decline, the reduction in the ability to sustain and switch attention, as well as mobility constraints are among other factors associated with growing old and having a negative impact on the ability to drive (Groeger, 2000; Kocherscheid & Rudinger, 2005). However, ageing is a continuing process associated with both losses and gains. While certain skills have their peak at an earlier age and deteriorate with increasing age, some skills, namely more strategic skills, are known to improve with increasing age. Improvement in "crystallized intelligence" or strategic skills can help an aged road user to maintain safe performance in traffic despite deterioration in some other skills. Indeed, experiencing difficulties in driving has been found to be related to voluntary reduction and cessation of driving (Braitman & McCartt, 2008; Lyman, McGwin & Sims, 2001; Rimmö & Hakamies-Blomqvist, 2002) and modification of driving patterns, including avoidance of risky situations (Stutts, 1998).

Previous research has demonstrated that older drivers are the safest group of drivers, and that they do not pose a threat to other road users' safety (e.g. Dellinger, Kresnow, White & Sehgal, 2004; Evans, 2000). In addition, older drivers also add to the traffic safety of other generations: the risk of serious injury to children is halved if driven by grandparents rather than parents (Henretig, Durbin, Kallan & Winston, 2011). The insurance industry has begun to recognize the longevity safety dividend by targeting younger old drivers (approx. 50-70 years) as a lower risk and less expensive group of drivers (<http://www.expertcardirectory.co.uk/over-50-companies-1.htm>).

The increasing older driver population has inspired various forecasts on accident rates. Some 15 years ago, these were rather apocalyptic, forecasting up to 400% increase in fatal accidents (Burkhardt & McGavock, 1999; Lyman, Ferguson, Braver & Williams, 2002). In 2004, a study based on Swedish accident data (Hakamies-Blomqvist et al., 2004) suggested that the older driver accidents may not be increasing with the same rate as the older driver population. A recent American study with

a comprehensive data set demonstrated that despite the growing number of seniors on the road, the number of older driver accidents has actually decreased with time and that the accident rate per driver has decreased more for older drivers than for others (Cheung & McCartt, 2011).

3.4.2 Older drivers' risk

The older drivers' accident risk is lower than that of other driver groups. Yet, a pernicious ageism persists in a perception among the general public of an increase in risk for older drivers (Martin, Balding & O'Neill, 2005), fuelled perhaps by an inappropriate quotation of an increased risk of accidents per mile. One reason for this is that people with low yearly mileages have more crashes per mile than those who have larger yearly mileages (Janke, 1991). Hakamies-Blomqvist, Raitanen and O'Neill (2002) were the first to demonstrate that the age difference disappears if comparisons between age groups are made "fair", that is groups matched for yearly mileage are compared. The so-called "low mileage bias" has been confirmed in other studies both based on self-reported mileage (e.g. Langford, Methorst & Hakamies-Blomqvist, 2006; Alvarez & Fierro, 2008) as well as on odometer-based readings, where it remained evident, even if on a reduced level (Langford, Koppel, McCarthy & Srinivasan, 2008).

Besides the "low mileage bias" the fact that older people compared to younger get more easily injured and killed in an accident because of their higher levels of frailty/fragility explains that their accidents more often appear in the official statistics ("frailty bias", see also Hakamies-Blomqvist et al., 2004; Keall & Frith, 2004; Meuleners, Harding, Lee & Legge, 2006; Box et al., 2010; Whelan et al., 2006). This poses an important question for automobile manufacturers: are the safety measures in cars appropriately adjusted for the increased frailty of older occupants (Morris, Welsh & Hassan, 2003; Pike, 2004)? Addressing the adaptation and age-attuning of occupant protection would not only represent an opportunity for major reduction of death and serious injury, but also a focus for technological advancement for the European automobile industry.

3.4.3 Older drivers' accident characteristics

Even though older people's accident risk is not higher than the risk of other age groups, there are accident types older people are more often involved in than other age groups and vice versa. The accident types typical for older drivers reflect partly their driving preferences and driving style (e.g. avoidance of poor driving conditions, not taking unnecessary risks) and partly age-related changes in skills (decline in perceptual abilities and sensomotoric skills, but increase in strategic skills).

Typical for older drivers are "error" accidents where many decisions have to be taken in limited space and time and mistakes can rather quickly cause collisions with other vehicles. Accordingly, a larger share of senior's accidents is collisions between vehicles, (Hakamies-Blomqvist, 1993; 1994b),

especially at intersections (e.g. Daigneault, Joly & Frigon, 2002; Fontaine & Gourlet, 1997; Hakamies-Blomqvist, 1994b; Stamatidis, Taylor & McKelvey, 1991). In Germany, for example, 18% of persons aged 65+ who were involved in an accident were accused of disregarding the right of way, while this was only relevant for 10% of 18-25 year old drivers (Statistisches Bundesamt, 2010, own calculations). The occurrence of intersection accidents is both an age-related and a cohort-related phenomenon (Hakamies-Blomqvist & Henriksson, 1999).

In contrast, seniors are underrepresented in single-vehicle accidents (Hakamies-Blomqvist, 1993; 1994b), which are more likely to be “violation” accidents caused by risky behaviour, such as inappropriate speed or alcohol consumption (Daigneault et al., 2002; McGwin & Brown, 1999). While only 6% of the drivers aged 65+ who were involved in an accident were accused of driving with inappropriate speed, it was 22% of the 18-25-year old drivers, for alcohol consumption it was 1% vs. 4%, respectively (Statistisches Bundesamt, 2010, own calculations). This is also in line with results from driver behaviour questionnaires showing that interpersonally aggressive violations are the least reported behaviour type among older adults, while errors and lapses are a bigger issue (Parker, McDonald, Rabbitt & Sutcliffe, 2000). Finally, a study of fatal accidents, however including only a limited number of cases, indicated that drowsiness was a less common factor that contributed to accidents among the old drivers (75+) compared to a middle aged group (35-55 years old), (Levin, Dukic, Henriksson, Mårdh & Sagberg, 2009).

4 Senior heterogeneity and the implications for ageing and transport

The previous chapter gave an overview of seniors' travel, mobility and safety issues. However, older people are not a homogeneous group. Their mobility behaviour and safety varies with variables such as gender, age or place of living. Certain subgroups are especially of interest here, namely subgroups which are growing (oldest old, older women and persons in single-households), those which appear especially disadvantaged and at risk of social exclusion (e.g. low income groups, rural residents), and those for which both criteria apply (e.g. ethnic minorities).

In the following, the research literature is reviewed⁸ in order to give an overview of the implications this heterogeneity of older population has in terms of safety and mobility. We focus in particular on age, gender, socio-economy, geography, ethnicity, and household structure and living arrangements.

Typically, the variables (e.g. gender and household-structure) are often related (more females living in single-person households, the oldest old are predominately female). This makes it more difficult to figure out the specific effect of a certain variable (unless the effects of co-variables are controlled for). Also, sometimes only the combination of specific characteristics, such as being female and at low income (in contrast to being male and at low income) might have an effect on mobility. These relations between variables will be addressed and interaction-effects will be considered. While it is relevant to divide and describe people based on single variables, the interrelation between variables also suggests describing people based on several variables at once. The last part of the chapter focuses on this issue and gives an overview of existing segmentation approaches for identifying similarities and differences of various segments of older people.

⁸ The results are based on a systematic literature research based on keywords provided for the respective subchapters. On the basis of these keywords international databases were searched as well as relevant national databases of the CONSOL partner countries (Austria, Czech Republic, Denmark, France, Spain, Sweden, UK) added by the known literature of the experts involved in the project, including project reports and other literature that is often not included in databases.

4.1 Age

Also in terms of age, the seniors are a heterogeneous group. The population of older persons consists of various ages, cohorts and generations. Usually the differences between different cohorts among seniors are observed with a cross sectional analysis, which can make it especially difficult to distinguish between cohort, period and age effects⁹. Some longitudinal studies do exist (e.g. Hjorthol et al., 2010), making it easier to assess how the seniors in the future will travel and behave in traffic.

4.1.1 Age and mobility behaviour

As outlined in Chapter 3.2.1 in this report, travel activities tend to decline and mobility needs change with increasing age. The licensing rates are lower in oldest groups, indicating driving cessation in advanced ages but also cohort differences between the seniors. The longitudinal studies have indicated that travel activities and license holding will be higher among the younger cohorts as they age (e.g. Hjorthol et al., 2010; see also Chapter 3.2.1). That is, the younger cohorts will maintain active mobility patterns and hold on to their license into high ages.

4.1.2 Age and road safety

The cross sectional analyses show that with advancing age, the number of accidents decreases but the severity tends to increase (e.g. Hakamies-Blomqvist, 1993; Evans, 1998). The oldest old have fewer accidents but when they do, they are likely to be killed or severely injured. This applies both to vulnerable road users and car drivers/passengers. Especially the oldest old are subject to “low mileage bias” due to lower exposure, and the traditional risk estimates that produce the U-shaped curve demonstrate sharply increasing risk with advancing age in the oldest age groups.

Studies have shown that the share of accident types and characteristics typical for older drivers changes with age. The share of these accidents (described in Chapter 3.4.3) increases with advancing

⁹ The cohort effect refers to the effects of being born at a specific time in history. Examining cohort effects can show how differences in socialisation and experiences between different generations can vary, and how specific characteristics will follow the cohort. Intra-cohort comparisons are made by following the same cohort at different points in time.

The period effect refers to effects limited to a specific period of time and applies to all cohorts. To investigate the period effect comparisons between the same age categories at two different times are done. In our example the economic situation can have had the same effect for all cohorts.

The age effect refers to the effects of growing older and is associated with the life span and the ageing process as such. Age effect is central in gerontology but can be hard to distinguish from the other effects, as they are always closely interrelated.

age, just as the share of other type of accidents decreases (e.g. Hakamies-Blomqvist, 1993; 1994b). This development is likely to reflect the age-related changes in driving skills, functionality, perceptual abilities and sensomotor skills.

However, it is not clear to which extent the observed differences between the different age groups indeed are age-related. A study by Hakamies-Blomqvist and Henriksson (1999) showed that the share of intersection accidents decreased in successive cohorts and the younger cohorts showed the age-typical accident picture at a somewhat later age than the older cohorts. The study indicated that the older driver typical accident patterns are both an age-related and a cohort-related phenomenon: age-related in the sense that they will emerge eventually, but with cohort-related variance in timing.

4.2 Gender

The majority of the older population is female and older women are the fastest growing segment among car drivers (e.g. Oxley et al., 2005). Since a first review on “Older female road users” in 2001 (Sirén, Heikkinen & Hakamies-Blomqvist, 2001), where it was concluded that elderly women in traffic had been “an invisible group”, research into this topic has increased (see for example D'Ambrosio et al., 2008; Oxley, Charlton, Scully & Koppel, 2010; Rosenbloom 2006a,b; Siren, 2005; Siren & Hakamies-Blomqvist, 2003; 2004; 2006).

4.2.1 Gender and mobility behaviour

Since the 1960s, great societal changes have taken place, which have had a big influence on gender roles and spheres traditionally defined as “male” or “female”. Higher education level and income among women have led to increasing mobility demands by women, reflected in a higher number of daily trips, distance travelled, and time travelled. Socio-economic changes have also contributed to women's higher car ownership and car use (Collet, Roux & Armoogum, 2012). Also car ownership among *older* women has significantly increased during the past decades, associated with greater car use and in maintaining a current licence in old age (Hjorthol, et al., 2010). However, older women are still less likely to hold a driving licence compared to men (e.g. Hjorthol et al., 2010; Li, Raeside, Chen & McQuaid, 2012; Siren & Hakamies-Blomqvist, 2006; Transek, 2005).

As it comes to gender differences in modal choices, women walk more often and travel more by public transport. Women make on average fewer daily trips, especially by car (e.g. Li et al., 2012; MON, 2009; Mollenkopf et al., 2004; Rosenbloom, 2006b; Siren et al., 2001). However, differences in mode choice between older men and women decrease, when driver status is controlled for, that is, only male and female drivers (or non-drivers, respectively) are compared (Rosenbloom, 2006b). Yet, when travelling in a personal vehicle, older women are more often than men passengers and not drivers (Hanson & Hildebrand, 2011; Li et al, 2012; Rosenbloom, 2006b; MON, 2009; Siren & Hakamies-

Blomqvist, 2006). One reason for this might be that older women are often discouraged by their husbands from driving and more often question their own driving abilities (Siren & Hakamies-Blomqvist, 2005; Rosenbloom, 2006b).

Women's travel has also been found to be limited to smaller geographical areas and to depend more on social factors. These differences to some extent decrease with age, which can be explained with social structures related to working life (Siren et al., 2001). As Hjorthol (2003) points out, it is important to base studies on differences in men's and women's travel behaviour on knowledge about activities on various social arenas which generate trips. Gender differences pertain especially to the involvement in the labour market, household work and responsibility for children and elderly relatives, and these differences have an impact on men and women's everyday travel activities and use of transport modes.

Examining older people's trip chaining, older women compared to men are more likely to make more complex tours (Golob & Hensher, 2007), particularly shopping tours (Su & Bell, 2012). This result is explained with men having fewer household obligations and thus less need to undertake complex journeys to save time (Su & Bell, 2012). Interesting in this context is also a result of Waara and Stjernborg (2010), who investigated older people in transition from a two person household to a one person household. Respondents who reported a positive effect of this transition on their ability to travel especially mentioned reduced responsibilities in the household, gained independence and extra time as reasons for that. Unfortunately, answers were not presented separately for men and women. In contrast, the answers of respondents who reported negative effects were divided by gender, showing that having become dependent on travelling by car as a passenger was the most common reason for reduced mobility after transition among the women. Also, becoming dependent on public transport was more common among women than men. This is in line with other studies which show that older women depend more on others for their personal travel (Siren & Hakamies-Blomqvist, 2006) and are more affected by loss of a spouse with regard to unfulfilled travel needs (Ahern & Hine, 2012).

In general, women report more unmet travel needs than men, which means that especially parts of their leisure activities remain unrealized (Hjorthol, 2013; Scheiner, 2006a,b; Siren & Hakamies-Blomqvist, 2004, 2006). Women also report more difficulties with all transport modes than men (Li et al. 2012), which could be due to both greater difficulties and a greater openness about difficulties. Women's transportation problems are significantly related to income and income-satisfaction, while this is not the case for men (Dubuis, Weiss & Wolfson, 2007). Thus missing financial resources are more likely a restricting factor in older women's mobility than in men's (see for example Siren & Hakamies-Blomqvist, 2004; Rosenbloom & Winsten-Bartlett, 2002).

While women's problems seem to be more related to the dependence on others and on public transportation, older men's problems result from their car dependent lifestyle, which leads them to be less prepared for life without a car compared to women (Ahern & Hine, 2012).

Another important barrier to mobility is perceived safety and security. This is especially true for older women (Davidson, 1999; Haustein & Kemming, 2008; Pain, 1997). Predicting the perceived danger in different situations alone in the dark, Haustein and Kemming (2008) could show that both age (60 years and above) and gender had a significant impact, however, the gender impact was considerably larger. Moreover, at the same level of (in)security, more women than men avoid situations in which fears are experienced (Haustein & Kemming, 2008).

As drivers, women are more likely to give up driving earlier than men (e.g. Bauer, Adler, Kuskowski & Rottunda, 2003; Hjorthol, 2013; Siren et al., 2004; Transek, 2005). Women and men tend to differ also in reasons for driving cessation. For men, the main reason is bad health (Hakamies-Blomqvist & Wahlström, 1998), while women more often give up their licence for various reasons, for example having no experience in driving or feeling insecure, no need for driving, or having a partner who drives (Hakamies-Blomqvist & Wahlström, 1998; Hakamies-Blomqvist & Siren, 2003; Hjorthol, 2013; Transek, 2005). Women are also more likely to be sufficiently physically fit to continue driving when choosing to cease (Siren et al., 2004).

D'Ambrosio et al. (2008) found that prior to driving cessation women are more likely than men to restrict their driving voluntarily. The differences were most pronounced in situations involving driving long distances or in unfamiliar areas. Also other studies found that gender has an impact on self-regulating behaviour (e.g. Charlton, et al., 2003; Gwyther & Holland, 2012; Hakamies-Blomqvist & Wahlström, 1998; Vance et al., 2006; Transek, 2005).

Studying older women's experience of car driving, Dillén (2007) found two patterns: Women who drove often and regularly talked about car driving and its consequences in positive words and valued the prospect of continuing to drive in the future. In contrast, women who had stopped driving showed different patterns reaching from feeling unease regarding different aspects of driving, to health problems and not being interested in driving at all. Also Hakamies-Blomqvist and Siren (2003) found that the personal driving history was strongly associated with driving cessation and continuation. Women who had driven most of their lives and had substantial driving experience were less likely to cease driving or had given up for similar reasons as men. These results suggest that confidence in one's own driving skills might be more related to driving experience than to gender. However, gender differences in confidence remain, even after controlling for driving experience and other background variables (D'Ambrosio et al., 2008). This indicates that socially constructed roles and expectations play a role in explaining observed gender differences.

4.2.2 Gender and road safety

The accident patterns of older female and male drivers are similar. However, while male drivers have higher absolute numbers of accidents, older women have higher accident involvement and injury rates

per driven distance than older men (Massie, Campbell & Williams, 1995; Stamatiadis, 1996). Age-related changes in accident characteristics (e.g. collisions in intersections) have been found to affect female drivers at an earlier age and to a higher degree (Hakamies-Blomqvist, 1994a). Due to their in general lower annual mileage, their physical characteristics, and the fact that automobilisation took place somewhat later among women, it seems that older women's accident rates in particular are affected by low mileage and frailty biases, as well as cohort related effects. Annual mileage is related to crash rate per mile (cf. Chapter 3.4). Lower annual mileage means also less experience and confidence in own driving. Women's accident risk has also been found to be associated with confidence in driving (Oxley et al., 2010). In addition, older women are not only petite, and thereby might not get the best protection from the vehicles passive safety equipment, but also have greater physical frailty. Meuleners et al. (2006) found that increased fragility explains at least 50% of the excessive injury risk incurred by older female drivers, whereas the pattern for male drivers was less obvious. Women over 70 years have also been found to be the most vulnerable age group with regard to serious accidents as pedestrians (Li et al, 2012). In addition, women are also more affected by non-fatal fall related injuries (Stevens & Sogolow, 2005) and perceive a higher fear of falling (Scheffer et al., 2008). Finally, they have also a higher risk of being injured in a non-collision incident on buses, which is related to travel frequency and possibly also to women's greater physical frailty (Kirk et al., 2003).

4.3 Socio-Economy

For a long time, older people have been regarded as having fewer economic resources than the average population. However, as Chapter 2.2.3 illustrates, differences between age groups have become less pronounced. Nevertheless, the income differences by age vary greatly from one country to another and also the roles of factors such as gender and education vary depending on a country in question.

4.3.1 Socio-economy and mobility

Car availability is strongly related to income as well as the number of trips a person makes and the travelled distance (e.g. Dft, 2009; INFAS & DLR, 2010, MON 2009). With regard to older people's travel behaviour it has been found that older people with a higher income make more trips (Tacken, 1998), are more likely to drive (Kim & Ulfarsson, 2004), and less likely to use public transport (Su & Bell, 2009). Financial reasons are also one reason among others for older people to stop driving a car (Hakamies-Blomqvist & Wahlström, 1998; Siren et al., 2012; cf. Chapter 3.3.3).

Siren and Hakamies-Blomqvist (2004) showed that those older persons, who made fewer trips and have unfulfilled mobility wishes were especially women, the oldest old, those without driving licence,

those with a lower educational level, and rural residents, which goes along with fewer financial or overall resources.

In a qualitative study by Knight et al. (2007) many respondents with lower incomes reported that transport cost restricted both the amount of travel they did and the transport modes they used. Due to high costs, journeys outside their local area, especially for social and recreational purposes, had to be reduced.

Scheiner (2006b) conducted several regression analyses to predict different aspects of older people's mobility as dependent variable. Here, income (and car-availability) turned out to be a significant predictor of leisure activity diversity and leisure distance. However, income (as well as car-availability) did not significantly contribute to explain leisure activity frequency, unfulfilled activity wishes and leisure satisfaction (Scheiner, 2006b). In a study by Haustein (2011) income was also not a significant predictor of the frequency of leisure activities but of the frequency of other activities (work, shopping and private errands). Moreover, income had a low but significant impact on the percentage of car use, even if other factors, such as car availability, were controlled for. Predicting the probability of having a transportation deficiency, Kim (2011) could show a significant effect of income.

Dubuis et al. (2007) found an interaction of gender and income variables with regard to transportation problems. In their study, women who reported transportation problems (e.g. using public transport alone in spite of perceived difficulties) had fewer financial resources and lower income satisfaction compared to those for whom transportation was not a problem. In contrast, socio-economic variables were not associated with transportation problems of men. As pointed out before, missing financial resources are more likely to be a restricting factor in older women's mobility than in men's and these interactions should be looked into in more detail (cf. Chapter 4.2.1).

Nilsson, Avlund and Lund (2011) found in a longitudinal setting that the combination of low financial assets and poor social relations significantly increased older people's mobility limitations.

With regard to education, Schwanen, Dijst and Dieleman (2001) as well as Evans (2001) have found a positive effect on out-of-home-mobility and public transport use, while in Haustein's (2011) analysis education showed no significant effects, neither on activity frequency nor on mode choice. As education is related to income, the effect on public transport use is contradictory to the results presented before, however Evans (2001) only included non-drivers in their study, while Schwanen et al. (2001) explains the effect with a higher probability of higher educated people to have commuted to work by public transport and keeping that habit when retired.

All in all, the results on socio-economic resources are not unanimous. While one reason for this might be different research methods used (controlling for other relevant factors, including interactions), another important reason might be the variations in the welfare system and the infrastructural conditions in countries, where the respective studies have been carried out. Depending on the quality

of available alternatives to a private car and the effort used to prevent social exclusion, for example, by providing subsidised access to public transport (where available) or taxis (where not), not having enough money to own and maintain a car might have negative consequences for mobility or not.

4.3.2 Socio-economy and safety

Socio economic factors may have an indirect effect on individuals' safety as they are likely to affect mode choice. Entering traffic as an unprotected road user is less safe, especially for older persons. Previous studies have indicated that economic factors play a role for many older persons in their decision on whether or not to continue driving (e.g. Hakamies-Blomqvist & Wahlström, 1998).

Economic factors such as income and family size are also likely to affect the choice of vehicle people drive. There is an indication that older persons tend to choose older, used cars (Choo & Mokhtarian, 2004). Studies have shown a safety advantage in driving newer cars with more advanced passive safety (Hels, Lyckegaard, Prato, Rich, Abele & Kristensen, 2012). The passive safety would be beneficial especially for older drivers and car passengers due to their frailty.

4.4 Geography and residential location

Current developments, such as urban sprawl and the withdrawal of public transportation in rural areas (cf. Ahern & Hine, 2012; Eriksson & Westlin, 2003) are likely to increase older people's car dependency and their dependency on others when they are not able to drive (any more). In this chapter, we describe how far different settlement structures affect older people's mobility and safety and what consequences these differences have with regard to older people's travel demands and mobility needs.

In a literature review, Linder (2007) points out that the relation between land use and older people's travel behaviour is not totally clear, and research results are often contradictory. Possible explanations for contradictory results are that different places of residence and settlement structures have been investigated. While variables like age or gender are easy to operationalise, the concepts of rural versus urban areas can show great variability with regard to density, availability of facilities and public transport. A rural area in Germany or the Netherlands markedly differs from a rural area in Finland, Ireland or Spain. In addition, a simple comparison of the mobility of people living in different settlement structures does not account for self-selection effects, that is, people who decide to live in rural areas most probably differ from urban residents on several characteristics. Thus results from multivariate analysis, which control for these background variables, give more insight into the effect of settlement structures on mobility behaviour. Still, it can be concluded that older people living in rural and urban areas face different problems and issues in their mobility.

4.4.1 Residential location and mobility behaviour

As results from national travel surveys show, people in rural areas undertake the same number of trips as people living in urban areas but travel longer distances. Moreover, urban residents undertake a higher percentage of their trips by public transport and walk more often, whereas people in rural areas use the car more often (e.g. INFAS & DLR, 2010).

Similar differences in mode choice related to residential location have also been found for older people. However, these differences between rural and urban residents are much more pronounced for non-drivers (Schwanen et al., 2001). While the number of trips is not significantly related to the location of residence (Dejoux et al., 2010; Ramatschi, 2004; Siren & Hakamies-Blomqvist, 2004), there seems to be a difference in the trip purpose. Persons from urban areas conduct more activities belonging to the category “education and culture” while older people from rural areas engage more in social activities (Ramatschi, 2004), most probable due to differences in cultural offer and variety.

According to results of a Finnish study (Siren & Hakamies-Blomqvist, 2004) rural residents are considerably more affected by unfulfilled mobility needs. In contrast, in a German study (Scheiner, 2006b) no effect of settlement structure on unfulfilled activity needs was found, when other factors, such as age, health and gender were controlled for. Besides different methods, a possible reason for these differences could be that rural Finnish areas are not comparable to (less) rural areas in Germany.

Even though older people’s car access is generally higher in sparsely populated areas than in urban areas (e.g. Schwanen et al., 2001), many older people (and especially older women) do not have a driving licence and a car. While in most urban areas restricted car access can be compensated by good infrastructure conditions, this is hardly the case in rural areas, where car access often is a precondition for independent life (cf. Ahern & Hine, 2012; Hanson & Hildebrand, 2011). In line with this, Mollenkopf (2002, p. 143) shows that satisfaction with mobility options in rural areas is not only determined by satisfaction with public transport (and other factors, such as age, ability to move around) but also by car access. In contrast, car access is not a significant predictor of satisfaction with mobility options in urban areas.

However, the majority of older drivers cease driving at some point of their lives. Based on focus groups with older people living in rural areas in Ireland, Ahern and Hine (2012) demonstrated that without a car, rural residents will strongly depend on others with regard to their mobility needs. In particular, social and leisure trips might not be conducted as people may not dare asking others for a lift when trips are not “essential”. But even for necessary, health-related trips, serious problems became evident. While urban citizens complain about public transport details, such as accessibility and comfort, rural residents simply cannot reach important destinations by public transport (Monterde-i-Bort & Moreno, 2004). Also Hanson and Hildebrand (2011) investigated how far older rural residents

could meet their current needs without a car. Using travel diaries, people were asked for each car trip they made, if and how they would undertake this trip without a car. Results showed that most of the trips (66%), especially the necessary ones, would still be made; however, mostly with the help of friends or family. Even if the number of trips people would like to conduct decrease with age, it is questionable whether family and friends would be available as a driver for the remaining trips. Rosenbloom (2010) showed that adult children of current older drivers are already worried about the burden they would have to carry when their parents stopped driving, indicating that there is a need for measures that allow older people to drive safely for longer and for alternative mobility options to be available for the time when their driving careers come to an end.

A study asking older persons about their use and preferences of public transport (Harris & Tapsas, 2006) identified taxis as the easiest form of transport to use for older people. However, the study also identified two problems of taxi use: taxis are regarded as a luxury older people often cannot afford and some taxi drivers are unwilling to take people on short trips. In a qualitative study by Knight et al. (2007) the main barrier for taxi use were high costs. Nevertheless, using a taxi was also seen as a reliable, fast and direct way of travelling and as a way to avoid the risk of crime on public transport. Older people in rural or isolated areas who do not drive were very positive about the idea of having taxi voucher schemes.

In general, high-density urban areas provide better conditions to maintain mobility in older life, especially where there is no car available. Results of Schwanen et al. (2001) indicate “that it is easier for seniors to take part in out-of-home activities if they live in highly urbanised environments.” (p. 354). Kim (2011) has found that older people who live in urban communities are less likely to experience lack of transportation compared to those who live in suburban communities. Further, the study has shown that having places to go within walking distance can compensate for the lack of vehicle accessibility. In line with this the number of facilities within walking distance has been found to decrease car use in favour of the use of other modes and to increase the number of non-leisure trips, such as shopping (Haustein, 2011). In contrast, older people “with high self-reported transport problems were more likely to be located in fringe and remote parts of the city and lived in areas where it was not possible to walk to a local shop” (Delbosc & Currie, 2011, p. 170).

Kim and Ulfarsson (2004) found that population density had a negative effect on the likelihood to drive, “probably capturing the greater access to transit and shorter distances to walk to destinations in more densely populated areas” (p. 123). Investigating the factors associated with trip making among non-driving 75+ people, Evans (2001) similarly found that housing density had a negative effect on car use (as passenger) and a positive effect on walking and general trip making. However, when density was controlled for, living in a central city showed a negative effect. This was interpreted as a negative effect of perceived safety, which might play a greater role in central city areas. In fact, it has been shown that older people (in contrast to younger) feel less secure in high-density areas in or close to the city centre (Davidson, 1999; Föbker & Grotz, 2006; Haustein & Kemming, 2008; Mollenkopf &

Flaschenträger, 2001), which support his interpretation of the results. It also shows that at least this type of urban area also bears restricting factors for older people's mobility.

4.4.2 Residential location and road safety

Rural pedestrians have been found to be more concerned about the hazards of walking in rural areas than their urban counterparts, related to the less safety-supporting features of rural roads (Monterde-i-Bort & Moreno, 2004). Aspects mentioned in focus interviews with Spanish senior citizens in rural areas, such as "no police enforcement, no barriers to cars, too much speed, no suitable crossroads" illustrate their problems (Monterde-i-Bort & Moreno, 2004, p. 140). Of the pedestrian accidents that occur on rural roads, a larger percentage is fatal (Larsson, 2009; Yannis, Papadimitriou & Evgenikos, 2011). Accordingly, providing better transportation alternatives to the car in rural areas should also include the improvement of pedestrian facilities.

In terms of driver safety, there is no clear evidence on differences in risk by residential location. Hildebrand and Myrick (2001) suggested rural drivers to have a higher accident risk, but did not control for the low mileage bias in their study. In general, the more complex driving environments, and majority of accidents are found in the urban areas.

4.5 Ethnicity

Along with the demographic change, European societies are not only becoming older but also more ethnically diverse. However, when focussing on older people today, the people who immigrated in the 1960's and 1970's to Northern and Western European Countries are of particular interest as they are just reaching retirement age (cf. Chapter 2.1.3). Unfortunately, there is no research with a focus on the mobility of this subgroup of older people.

So far, research on mobility of persons with foreign background is dominated by US studies. They show that recent immigrants have different travel patterns compared to both individuals born in the US and immigrants who have lived in the US for longer periods of time and that travel patterns vary with place of birth (e.g. Blumenberg & Shiki, 2007; Tal & Handy, 2010). Differences in travel patterns can be explained by differences in social and demographic variables, such as lower car ownership, lower household income, greater household size, lower licensure rates, and population concentration in urban areas (cf. Contrino & McGuckin, 2009), most of them associated with immigrants' higher use of public transportation. However, it has been shown that some differences remain between immigrant groups and non-immigrants even when controlling for such characteristics, indicating that variables, such as the cultural background, attitudes or prior experience have an impact on travel behaviour (Blumenberg & Shiki, 2007; Tal & Handy, 2010). A study from the Netherlands (Harms, 2007) comes to similar conclusions. Here, the four biggest immigrant groups were looked into: Turks, Moroccans,

people from Surinam, and the Antilles. The groups showed great differences regarding number of trips, travel time and covered distances both from each other and from the Dutch population. While a lot of differences could be explained by varying social or spatial factors, some differences remained when those factors were controlled for. Most pronounced was that Turkish and Moroccan women often stayed at home for the whole day and used the bike to a much smaller degree than all other groups, which could only be explained with different cultural and/or religious traditions. Similarly, Reutter and Suhl (2011) found that women with a Turkish background living in Germany are less likely to be licensed and less likely able to ride a bike compared to Germans as well as persons with different immigrant backgrounds. With regard to reasons for not owning a car, people with a foreign background most often stated that a car was too expensive, whereas for Germans age and health restrictions were the main reason for not owning a car¹⁰.

One of the few European countries where the ethnic background is integrated in the national travel survey is the UK, asking for the country of birth as well as for the ethnic group respondents belong to (DfT, 2011). Differences in car availability are found which contribute to differing travel patterns across ethnic groups, reflecting also the differing distribution of these groups between urban and rural areas (DfT, 2009). Like in the US, black and ethnic minority groups are more likely to depend on public transport than white adults because of limited car access. At the same time fear of racial attacks and language difficulties are barriers to public transport use (DfT, 2007). In a UK study (CSR Partnership, 2002, as cited by Smith et al., 2006), it was found that around half of Bengali/Bangladeshi women, and around 20% of Bengali/Bangladeshi men, Pakistani women and men, and Punjabi men did not use public transport due to problems speaking English. Another possible reason for not using public transport of Muslim women might be the segregation of genders in their country of origin (Peters, 2011; Roomi & Parrott, 2008) and the opinion that women should only travel accompanied by family members or female friends (Jali & Rahman, 2011).

None of the studies mentioned so far made any distinction of age groups. Still it can be assumed that lower car access and higher use of public transport can also be found in groups of older immigrants as well as gender differences within immigrant groups. This is supported by findings of Rosenbloom and Winsten-Bartlett (2002) who found African-American and Asian older women (65+) to be only half as likely as compared men to hold a licence. In addition, African-American older women were only half as likely as white women to be licensed. In a UK study (CSR Partnership, 2002, as cited by Smith et al., 2006), older Gujarati, Bengali/Bangladeshi and Chinese women were found to be even less likely to be licensed (1-3%) compared to older African women (11%). Finally, Kim (2011) could show that female gender and belonging to the non-white minority is significantly associated with a lack of transportation even if income and driving ability are controlled for. Thus, the combination of being old,

¹⁰ It has to be taken into account that the sample of non-immigrants was older, which probably explains parts of the differences.

female and immigrant seems to be especially disadvantageous with regard to possibilities of out-of-home mobility. Still, data in this topic is very restricted, mainly because ethnicity is not included in most of the European national travel surveys. In addition to more descriptive data, more in-depth studies are needed that explain differences between ethnic groups taking into account aspects such as travel socialisation, attitudes and cultural norms.

4.6 Household structure and living arrangements

There is a noticeable increase of single-person households. Partly because the population is ageing (and thus is more likely to be widowed), and partly because living without marrying or having a partner has become more common. Also, older people are nowadays less likely to live with their children or grandchildren (EC, 2010).

Living in a single-person household (which should not be equated with being a single, i.e. without a partner) has been found to be related to a higher level of mobility (Haustein, 2006). According to Kunert (1994, p. 148) the appeal or restraint to be mobile seems to be higher for people in single-person households compared to people living together with others. Results also imply that people in single-households are more oriented towards their closer neighbourhood (Haustein, 2006; Kunert, 1994), maybe because they are less restricted in choosing a place to live. While people in single-person households are generally associated with a higher amount of mobility, for older people the opposite seems to be true. While young people in single-person households (below 30) show the highest mobility rate (94% mobile at requested day) of all household forms, older people (60 and above) in single-person households show the lowest (82%; INFAS & DLR, 2010). They are also less likely to own a car compared to both other age groups in single households as well as older people in other household forms (INFAS & DLR, 2010).

Investigating older people's trip chaining behaviour, Su (2007) found that living alone is associated with increased trip complexity. This could possibly be explained with the lower car availability in single-households. Golob and Hensher (2007) found that "after the age 64, travel demand shifts from car driving (...) to car passenger and then to public transport in complex trip chains, especially for singles and for all women" (p. 298). Bell et al. (2010) found that older people not living alone more often state that the car is their preferred mode of transport and evaluate their mobility more positively. However, comparing out-of-home mobility before and after the transition from a one to a two person household, they found no significant differences. Waara and Stjernborg (2010) compared older people in single and two-person households and those in transition from a two person household to a one person household. Also in their study, respondents living in a one person household were more dependent on walking, public transport and special transportation service and less satisfied with their possibility to travel than those in two person households. However, a majority of the respondents (59%) in transition stated that the transition from a two person household to a one person household had a positive effect

on their possibilities to travel, mainly because of reduced responsibilities in the household, gained independence and extra time. In contrast, 41% experience a negative outcome on their possibilities to travel because of the transition, especially with regard to depending on public transport and on catching a ride with someone else.

Older people in single-households with reduced mobility options might be a group especially affected by unfulfilled travel needs and social isolation because of missing contact partners within the household context. Due to a higher living expectancy and a lower car-access, this especially applies for women, who are also less likely to have the resources to buy assistance or the services they need as they face mobility problems (Rosenbloom & Winsten-Bartlett, 2002). According to Siren and Hakamies-Blomqvist (2004), female gender, living alone, not having a driving licence, and belonging to the group of the oldest old are related to unmet travel needs. Based on focus groups, Ahern and Hine (2012) found that older women are seriously impacted by loss of a spouse in terms of their unmet travel needs as they are less likely to drive and to own a car. In contrast, it seems that licensed women without a partner are forced to be more independent, so they are less likely to self-regulate and give up driving, and as a result have more confidence in their driving skills, which again prevents them from giving up driving (D'Ambrosio et al., 2008; Oxley et al., 2010).

According to a study from New Zealand (O'Fallon & Sullivan, 2009) mobility of older people in one-adult households seem to be adapting towards the mobility of older people in two-adults households: While 1997/98 only 48% of people aged 65+ in one adult households travelled on two out of two travel days, it was 60% in 2004/07. In contrast, for people in two-adult households the rate was largely unchanged (62% vs. 64%). Signs for a similar development in Europe however could not be found.

All in all, living in single-household seems to be associated with lower car access, lower satisfaction with mobility options and a lower level of realised mobility for older people. However, a part of these differences could probably be explained by age and gender effects as the older old and women are overrepresented in single-person households. Studies based on multivariate analysis are needed to get more insight into the relative importance of the different factors on older people's mobility behaviour. Indeed, the results of a regression analysis predicting older people's activity frequency (Scheiner, 2006b) slightly challenge the results presented so far. Although the model can only explain eleven percent of the variance in older people's activity frequency, it includes some interesting results. The most important determinants of activity frequency are the physical ability to move and the social network. Most interesting with regard to the impact of household structure is, however, that being older than 70 years in combination with living together with a partner reduces the level of mobility. Scheiner explains this with two factors: First, older people living alone are more forced to satisfy their needs for social contact out of home (cf. Kunert, 1994; Schwanen et al., 2001). Secondly, the high number of persons needing care among couples in very old age might reduce the activity frequency of the respective partner, which is supported by his data, especially for older women nursing their husbands. Knight et al. (2007) have also shown that caring for a sick partner or spouse reduces the amount of

mobility. Nilsson et al. (2011) found that living alone limited the independent mobility of older men, who are probably more often the care-receiver in a partnership but not the mobility of older women (care-giver) and conclude that “older men appear to rely more on their spouse for social support than women (p .611). In line with Scheiner’s results, multivariate analyses conducted in other studies show that older people’s leisure activities (Haustein, 2011) or general mobility (Evans, 2001; Schwanen et al., 2001) increase with decreasing household size/living alone when other factors, such as age and gender are controlled for.

With regard to unfulfilled travel needs, living alone or with a partner has either been found to be related (Siren & Hakamies-Blomqvist, 2004) or not (Scheiner, 2006a,b). More research is needed to help decide if these differences are due to country-specific characteristics, different applied methods or other factors. Living alone or with a partner seems to have different consequences for older men and women, so also interactions of gender and household-variables should be considered in future research.

In addition to the changes in household structure, more diverse family living arrangements are gaining ground (EC, 2010). Today, being married and living together with the partner is only one form of living among others, such as living without a partner, cohabitating, being together with a partner but in different households (living-apart-together, LAT) and so on. It has been shown that these different living arrangements are connected with different levels and patterns of mobility (Haustein, 2006). Especially LATs turned out to be highly mobile in their leisure time. While one might in the first instance think about young couples in this context, it has been shown that it is also a relevant form of living for retired couples, who often do not want to give up their place of living when having a new partnership in old age (Levin, 2004). While older people who become widowed or divorced reduce their mileage (Braitman & Williams, 2011), it can be assumed that those who find a new partner have a higher level of mobility than those who do not. However, if people are having a partner in a different household is usually not considered in national travel surveys and thus the respective knowledge is rather restricted. Living in a single-person household is not necessarily equal to being a single just as singles can also be found in multiple person households.

4.7 Segmentation of seniors

Studies that examine older people’s mobility behaviour, preferences and possible limitations often conclude that they deal with a quite heterogeneous group (e.g. Alsnih & Hensher, 2003; OECD, 2001; Siren & Hakamies-Blomqvist, 2004). One way of dealing with this heterogeneity is the segmentation of older people into relevant subgroups. The approaches of segmentation most often used in transportation planning are based on behaviour or socio-demographic variables. A behaviour-based approach defines the segments by using different travel modes and the frequency of their use, respectively. The methodological weakness of behaviour-based segmentations lies in the lack of an

explanation for behaviour. This approach can only describe mobility behaviour and does not provide information about the underlying processes that determine that behaviour. A segmentation approach that takes into account socio-demographic characteristics of traffic participants avoids these restrictions. Age, gender, occupation, household size, and income as well as car ownership are socio-economic and demographic characteristics that are highly relevant for mobility behaviour and can be used for a detailed segmentation of the population in aggregate transport models for whole countries or continents like Europe (De Jong, Gunn & Ben-Akiva, 2004). In contrast, psychographic approaches are mainly based on attitudes and values and allow for the identification of meaningful groups to be used in designing targeted hard and 'soft' transport policies (e.g. Anable, 2005; Hunecke, Haustein, Böhler & Grischkat, 2010). In addition, the attitudinal profiles can be used to change attitudes by means of persuasive communication strategies, whereas socio-demographic factors cannot be changed by behavioural interventions.

The different segmentation approaches have also been applied in the context of older people's mobility behaviour. Rudinger and Käser (2007) segmented older people on the basis of the variety and frequency of their activities. Four groups were differentiated: Older people in the first group (18%) were not very active regarding both diversity and frequency. They belonged mainly to the older old and were restricted with regard to health status, financial resources and social networks. Older people in the second group (50%) showed an average variety and a big range regarding frequencies of activities with up to 900 activities per year. Their ability to move was slightly restricted but they evaluated their health status positively and their satisfaction with life and leisure was also high. Older people of the third group (31%) showed a big variety regarding the activities which they performed quite often. It was mainly the younger seniors with huge social networks and very good health. The few members of the fourth group (1%) showed only a few different activities (esp. social and sports) but these were carried out very intensively.

Aigner-Breuss et al. (2010) differentiated between three behaviourally homogeneous groups based on their car use: (1) older people who predominantly use the private car (66%), (2) selective car users, which are people who choose the mode of transport that suits best to a given situation (19%), and (3) older people without access to a private car (15%). For people in the first group the bike was only used in leisure time, in the second group the bike was used more frequently, also in every-day mobility, in the third group a bike was seldom owned and used. People in the third group were most restricted with regard to financial resources, education, and mobility. The second group had the best financial resources. They were also younger, least restricted and more open to new media and technologies.

Based on socio-demographic variables (e.g. age, gender, driving licence) Hildebrand (2003) identified six distinct lifestyle clusters, which were found to have significant differences in mobility behaviour and activity engagement patterns, for example, the so-called Affluent Males, who were all licensed, had high car availability, were rather young and well off, and in contrast to these the Mobility Impaired, who were not licensed, often disabled, older and mostly female.

In the project SZENAMO older people were clustered based on the variables health, household structure, and occupation resulting in three segments called “Mobile persons” (44%), “Slightly restricted mobiles” (26%) and “Highly restricted mobiles” (30%; Bell et al., 2010). The three groups differed significantly with regard to age, mode choice, out-of-home-mobility, activities, mobility needs, and the subjective evaluation of their mobility options.

In the European MOBILATE project (Mollenkopf et al., 2004) older people were clustered according to their trip frequency, variety of transport option, activity variety, and mobility satisfaction. As a result, four subgroups were identified, reaching from a high outdoor mobility and mobility satisfaction (Subgroup 1) to low mobility and satisfaction (Subgroups 4). Car use, health status, financial and educational resources, as well as percentages living in an urban area decreased gradually from group one to four, indicating that clusters differed more quantitatively than qualitatively.

Based on the results of regression analyses on the determinants of older people’s travel behaviour, Hausteine, Hunecke and Kemming (2008) used mobility specific attitudes as well as car availability and age to create six distinct segments of older people, which showed strong differences in travel behaviour. In a subsequent study (Hausteine, 2012) based on a bigger sample of older people and a more specific age-related questionnaire, accessibility of facilities by walking (e.g. to the doctor, opportunity for daily shopping), income and the size of the social network were additionally included in the cluster analysis as they also turned out to be significant predictors of older people’s mobility behaviour. Compared to the former study, the number of clusters was reduced to four “core” segments, namely one better-off car-oriented type (“Affluent Mobiles”), one self-determined type, open to the use of all modes of transport (“Self-Determined Mobiles”) and two more restricted types with regard to mobility, health and income, one dependent on the car (“Captive Car Users”), and the other on public transport (“Captive Public Transport Users”). The modal split of the four segments is presented in Figure 5. As illustrated in Table 8, the four clusters show similarities to clusters identified in former studies based on different populations and variables.

Not surprisingly, Affluent Mobiles and Self-Determined Mobiles, were more satisfied with their mobility options than the more depending types. At the same time, they exercised a higher amount of leisure time activities. Both types appear quite unproblematic, also with regard to their mobility when becoming older. Self-Determined Mobiles because of their flexibility and openness to all modes reflected both in their attitudes and their modal split (cf. Figure 5). Affluent Mobiles because of their high income, a huge social network and their openness to new media, which indicated that they might be able to compensate future mobility problems partly by online services. In contrast, Captive Car Users are characterized by a negative view of all modes but the private car, as well as health restrictions and a rather peripheral location. For the future it seems to be important to prevent these individuals becoming car-dependent as they appear to be the most disadvantaged of all. Once Captive Car Users are no longer able to drive by themselves, they will be highly dependent on others to fulfil their mobility needs. This dependency is also recognized by adult children of older drivers and often

regarded as a burden (Rosenbloom, 2010). Also Ahern and Hine (2012) showed that people with a car dependent lifestyle face big problems when they have to give up driving. Most of the Captive Public Transport Users have no access to a private car. As most of them live rather centrally, this does not seem to be a problem, as positive attitudes towards public transport suggest. However, it can be assumed that the group of Captive Public Transport Users is decreasing as in the future a growing number of older people (especially women) will possess a driver's licence and thus will not depend on public transport any longer—at least as long as they can afford a car, which is another restricting factor in this group.

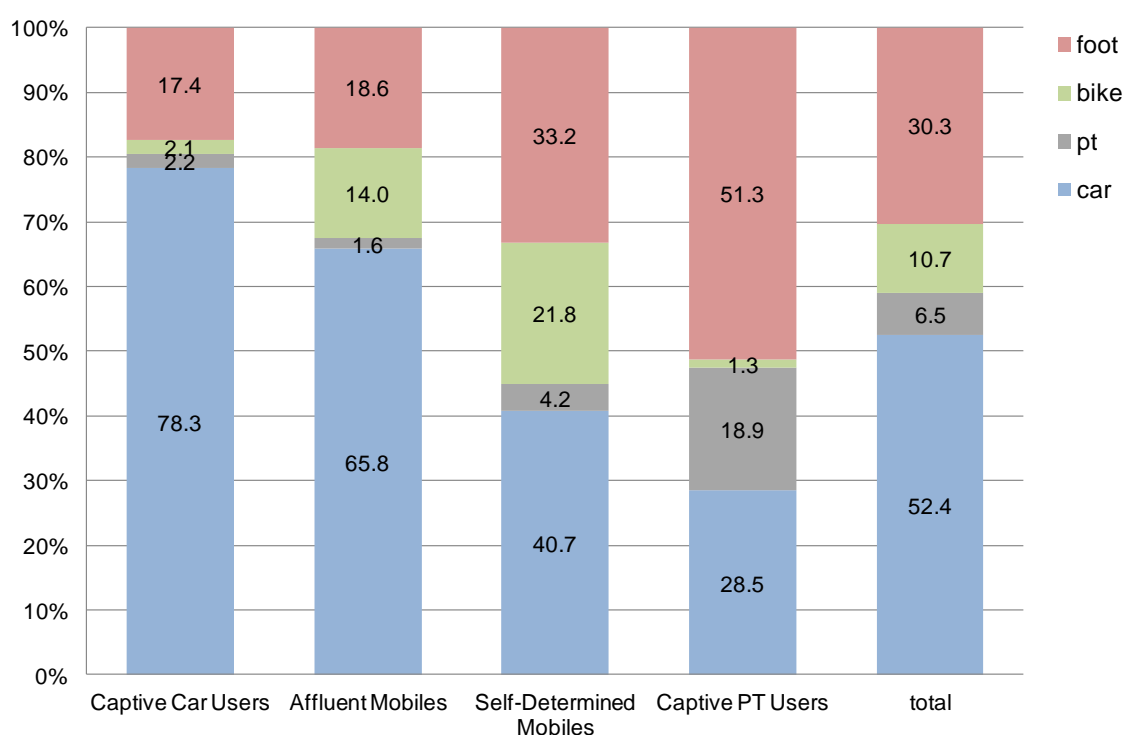


Figure 5: Modal Split of the four segments identified by Haustein (2012)

Finally, the findings of the previous sub-chapters are reflected in the four segments of older people: Women are overrepresented in Captive Public Transport Users; lower-income groups and persons living in single-households are overrepresented in both restricted types, and finally living in a more peripheral area is associated with car-dependence and lower satisfaction with mobility options. Accessibility appears to be a key variable for older people to stay mobile. While in districts of high accessibility restricted car access can be compensated by good infrastructural conditions, for older people living in the suburbs improvements of accessibility are necessary to ease car dependency.

Table 8: Overview of different segmentations of older people and the relation between the resulting segments

	Aigner-Breuss et al., 2010	Hildebrand, 2003	Bell et al., 2010	Haustein et al., 2008	Haustein, 2012
variables	car use	socio-demographic and household variables (e.g. driving licence, head of household)	health, household structure, occupation	socio-demographics, infrastructure, mobility-related attitudes	socio-demographics, infrastructure, mobility-related attitudes
segments					
Car oriented but restricted in mobility	Older people who	Disabled Drivers (5%)		Restricted Mobiles (11%)	Captive Car Users (24%)
Car-oriented, highly mobile	predominantly use car (66%)	Affluent Males (39%) Mobile widows (29%)	Mobile persons (44%)	Mobile Car-Oriented (20%)	Affluent Mobiles (23%)
Open to all transport modes	Selective car users (19%)		Slightly restricted mobiles (26%)	Self-Determined Mobiles (21%)	Self-Determined Mobiles (30%)
Captive public transport users	Older people w/o access to a private car (15%)	Mobility Impaired (12%)	Highly restricted mobiles (30%)	Pragmatic PT-Oriented (15%)	Captive Public Transport Users (23%)
others		Workers (11%)		Bike-Oriented (19%)	
		Granny Flats (4%)		Eco-Friendly PT-Oriented (14%)	

In the future, longitudinal research could give insight into the question how stable mobility types are and in how far mobility attitudes and health restrictions follow from specific mobility patterns (such as using the car only) and/or vice versa.

5 Disciplines central for further understanding of the issue of ageing and transport

Demographic change leading to an increased longevity has impacts on different levels, both individual and societal. For many aspects of society and people's lives, it has repercussions, either positive or negative, entailing new policy decisions. Problems and changes occurring with this big demographic change have constituted an important research theme for many disciplines among the social and human sciences, during the last twenty years. Some of the research questions from these disciplines or results about ageing may be of interest for a focus on ageing and transport. That is the case for research on traffic behaviour, but also social and political sciences, gerontology and geriatrics, and neuropsychology.

The following chapter provides an overview of theoretical, empirical and methodological perspectives and recent advances in these different disciplines relevant for ageing and transport. Depending on the considered discipline, the research results referred to are either linked to older people's mobility and safety directly, or they are focussed more generally on ageing with an impact on the transport issue.

5.1 *Gerontology and geriatrics*

The empirical and theoretical advances within gerontology and geriatrics are of great relevance to the issue of ageing and transport. More specifically, the fields of social gerontology and the studies on functionality and health are of relevance, and the impact of both gerontology and geriatric medicine has been to help restore an appropriate balance between mobility and safety, as the early literature on older people had an unhappy and unjustified emphasis on safety at the expense of mobility.

Geriatric medicine has also promoted a salutogenic approach to the interplay between age-related disease and driving, including studies showing that general rehabilitation can improve driving skills (Marottoli et al., 2007), and more measured and enabling approaches to driving with major illnesses of later life, for example dementia (Breen, Breen, Moore, Breen & O'Neill, 2007; Carr & Ott, 2010). Nearly all textbooks on geriatric medicine now include a chapter on driving and transportation.

5.1.1 Social and cultural aspects

The field of social gerontology has expanded significantly during the last 15 years, introducing several new fields and topics of study. Among the most prominent recent research themes are the third age (time of active retirement, before the age-related physical limitations are notable), the baby boomers' ageing, gendered ageing, social inclusion/exclusion, ageing in place, technology in everyday life, and diversity (ethnic, cultural, gender-related, economic) in ageing. Most of these themes are of importance when considering ageing and transport. However, many of them have hardly been addressed in mainstream research on older road users.

Gender

Gender in particular has been addressed surprisingly rarely in studies on ageing and transport, although the largest expected increase in the older road user population is among women. Older women are also the fastest growing segment among car drivers (e.g. Oxley et al., 2005). There are profound differences in the mobility and travel of older women and men (Hjorthol & Sagberg, 2000; Siren & Hakamies-Blomqvist, 2006; Rosenbloom, 2006a), which was described in more detail in Section 4.1. Too often, however, studies treat gender as a simple background characteristic and imply simply that gender per se influences travel and mobility (c.f., Rosenbloom, 2006a, Siren, 2005; Siren & Hakamies-Blomqvist, 2003). Here, the social gerontological and gender theoretical approaches can truly enrich the research illustrating how gender is not just gender, but something that is constructed and becomes visible through access to private car, driving licence, economical inequalities, health and disability, and housing.

Life course and generations

In social gerontology, the concept of life course is central. When the older (road user) population is growing more diverse as regards not only cultural and social background characteristics, but also age and cohort, the life course perspective can be useful. The life course perspective views ageing as constructed throughout individual's life and the present and future events/life patterns /expectations as being shaped through earlier events (Hooyman & Kiyak, 2008).

The life course perspective is especially fruitful when considering the highly diverse older road user population of the future, and especially as regards to baby boomers as older road users of the future. Their ageing is cohort-bound in terms of the cultural, social, educational and nutritional backgrounds they have, for example, as they tend to differ in these from their parents' generation. Also, their expectations and how they view themselves as old in the future will be constructed through the experiences they have had. Their 'future-story' will inevitably reflect their history (Robins, 1995), and this is highly relevant when planning the transport system of tomorrow.

So far, only a few studies have addressed directly baby boomers' travel and transportation and tried to grasp the generational dimension of the issue. Findings from a Swedish report (Hakamies-Blomqvist, Henriksson, Anund & Sörensen, 2005) showed that the Swedish baby boomers expected an active old age with active mobility and travel patterns. The report highlighted also the importance of the boomers as providers of informal transport services to older relatives and friends. Previous research has indicated a notable increase in licensing rates and car access in the older population during recent decades (e.g. Hjorthol et al., 2010; Ottman, 2010; Rees & Lyth, 2004), and it seems that older people are making more daily trips and are becoming more mobile (INFAS & DLR, 2010; Miranda-Moreno & Lee-Gosselin, 2008; Rosenbloom, 2001), especially in the social/leisure category (e.g. Arentze et al., 2008; Hjorthol et al., 2010; INFAS & DLR, 2010; van den Berg et al., 2011) and with regard to car trips (e.g. INFAS & DLR, 2010; Newbold et al., 2005; OECD, 2001; Rees & Lyth, 2004; Tacken, 1998). The new generations of older people will also be likely to keep their licences into old age (Hakamies-Blomqvist et al., 2005; Hjorthol & Sagberg, 2000). Altogether, it is expected that the ageing baby boomers will have a significant impact on the transportation system, but it is less clear what the impact will be (Coughlin, 2009).

Life course perspective can also be helpful in understanding the transport related implications of various life transitions, such as children moving out, retirement, and occurring disabilities. Data on travel activities show that retirement is a factor that influences travel practices. Interactions of various factors within transitions are also interesting. Health has an effect on retirement (see for example Deschryvere (2005) for an updated literature) but does retirement has an impact on health and consequently travel practices? The interactions can be explored from epidemiological and public health perspective. Alavinia and Burdof (2008) calculated associations between health and other determinants and being retired, unemployed or homemaker (for 50-64 years old Europeans). They showed that in many European countries poor health, chronic diseases, and lifestyle factors were associated with being out of the labour market. More specifically, Coe and Zamarro (2011) studied the health impacts of retirement. The results suggest that retirement has a health-preserving effect on overall general health.

Ageing and technology

Great developments have taken place in the technological focus of everyday life, and this has implications on the lives of all persons regardless of age. The issue of ageing and technology is relevant in the contexts of both social connectedness and social relations as well as the use of new technologies in transport. The way seniors are familiar with new technologies is a research issue that has emerged these last 15-20 years. In a recent study, Li and Perkins (2007) analysed the attitudes towards technology among older Americans and showed that the seniors view technology in the same way as the general public and that education has a bigger influence on the willingness to learn about

new technology than age does. Lee, Chen and Hewitt (2011) found that seniors' attitudes towards new technology and its use are also cohort /age dependent.

Ethnic and cultural diversity in ageing

The methodological and theoretical advances of social gerontology and, more broadly, social sciences can prove to be helpful for transport studies when tackling the issues of ethnic and cultural diversity. So far, diversity of the older road user population is rarely addressed in studies on ageing and transport. Some, mainly US studies, have analysed ethnicity as a component on travel behaviour in old age, and the general conclusion is that ethnicity plays a part in travel patterns, travel needs, and – through different family compositions and living arrangements – also in the needs for external help in transport (Rosenbloom & Winsten-Bartlett, 2002; Contrino & McGuckin, 2009).

5.1.2 Functionality and health

Health gerontology and geriatric medicine address the issues of health and functionality in old age, and within the field, several lines of research relevant for ageing and transport can be identified.

Maintaining functionality in old age

Epidemiological research on predictors of maintaining functionality in old age is an important resource for understanding why staying active and independent is a health matter both on an individual and on a societal level, and consequently, why satisfying transport needs in old age is crucial. Previous research has shown that social and physical activity and independency are preconditions for maintaining functional capability (Avlund et al., 2004; Mack, Salmoni, Viverais-Dressler, Porter & Garg, 1997), and in many cases, for living an autonomous, non-institutionalised life. Social activity in old age has been found to be associated with smaller likelihood of developing disabilities (e.g. Everard, Lach, Fisher & Baum, 2000; Sabin, 1993). Loss of independence in old age is demonstrably connected with an increase in both private and public costs (Guralnik, Alexih, Branch & Wiener, 2002).

A public health concept that has emerged during the last 15 years is “active ageing”, based on the idea of “successful ageing”. While highly debated within gerontology, active ageing has been set on the agenda of many public authorities responsible for the ageing issues. Keeping seniors mobile can be seen much in line with the ideas of decreasing dependency, need of support and inactivity in old age.

Variations in health

Another important research theme is functionality and health in different cohorts and different sub-groups.

Several recent studies have focused on the cultural differences in health and health disadvantage (e.g. Avendano, Glymour, Banks & Mackenbach, 2009). Educational level has been found to be associated with higher incident events of poor health, chronic diseases and disability, but it is less consistently associated with new events of long-standing illness (Avendano, Jürges & Mackenbach, 2009).

Health differences by cohorts, and forecasts regarding the large baby boom cohorts and their health are also issues that have direct implications to transport issues. In the future, the number of the oldest olds will increase significantly as life expectancy increases. At the same time, the ageing new cohorts are likely to differ from the preceding cohorts regarding their health and functionality, meaning that the activity and mobility patterns of today's older population no longer apply. Thus, it is relevant to include knowledge on functionality and health into predictions on the future travel demand and service needs.

Dementia and driving

Finally, the extensive recent research activities regarding dementia and other cognitive impairments are of great relevance for the issue of ageing and transport. This knowledge is important when trying to understand the difficulties people with cognitive impairments experience in traffic, be it as pedestrians, car drivers or users of public transport, and when trying to design the systems to meet their needs. First insights into the difficulties people who had a stroke perceive in traffic were provided by Logan, Dyas, and Gladman (2004). Recently, Risser, Iwarsson, and Ståhl (2012) explored in semi-structured interviews combined with participant observations what difficulties persons with functional limitations experience when using public transport. Barriers restricting autonomous outdoor mobility were not only well-known infrastructure problems or ergonomic shortcomings in the buses but especially specific issues relevant for persons with cognitive limitations, such as problems of interaction with fast moving car traffic, difficulties in obtaining all the necessary information, and communication problems with the bus drivers.

The information on cognitive impairments is also relevant when examining and understanding the self-regulatory behaviour of car drivers and driving cessation in connection with cognitive impediments. So far, little is known about the choices and decisions drivers with mild cognitive impairment make in terms of regulating or stopping driving. Some might voluntarily choose to cease driving even if it was possible to safely continue to do so possibly with help of technologies or training. Recent studies show that mild cognitive impairment only has a limited effect on driving performance (Frittelli et al., 2009; Wadley et al., 2009).

5.2 Differential psychology and neuropsychology

The perspectives from differential psychology and neuropsychology are of high relevance for the topic of ageing and transport. Within these fields, basic knowledge on personality psychology and psychological testing, as well as certain recent methodological advances, are especially relevant.

5.2.1 Diversity between the older people: personality and emotional issues

Personality can be defined as dimensions of individual differences in tendencies to show consistent patterns of thoughts, feeling and actions (McCrae & Costa, 2005). While the associations between personality, driving style and safety have been widely explored, surprisingly little attention has been paid to the issue in the context of older drivers (Adrian, Postal, Moessinger, Rasclé & Charles, 2011). Yet, this would be highly relevant. Emotional and psychological changes undergone as we age, have an impact on everyday functioning, including memory and decision-making.

Adrian et al. (2011) made an attempt to evaluate the link between personality traits and real traffic driving performance among older drivers. In their experiment, 42 older drivers from 60 to 82 years old (21 females and 21 males) were evaluated in their driving performance by the Test Ride for Investigating Practical fitness to drive and in their personality traits through several classical questionnaires and scales. Their results indicated that older drivers with high level of extraversion have poorer driving performance. This could be because they feel more confident about their driving. It is interesting to note that no relation was found between sensation seeking and driving performance..

5.2.2 Neuropsychological testing and cognitive training for older adults

Neuropsychological tests and techniques are widely used in fitness to drive assessments. A thorough understanding of the techniques, including their validity and reliability, limitations, and proper use of them is essential.

In the neuropsychological testing area of work, one of the significant improvements will come from the development of computerised testing. The computerised administration of neuropsychological tests can have several advantages; it allows testing algorithms that are too difficult to implement with paper and pencil tests, to have a more complete standardisation of test administration, to prevent error scoring and to collect response times with milliseconds accuracy. Finally, it also presents the possibility to use online referential databases to further inform the test interpretation (Randolph, 2002).

However, it should also be considered that computerized tests can also have some disadvantages because older people are not as computer friendly as are younger people, even if this difference tends

to decrease over the next cohorts of older people. Similarly, the use of driving simulators in driver testing can be limited by the fact that older drivers are more subject than younger to the simulation adaptation syndrome. In general, the choice of the neuropsychological tests to use for older road users should be carefully considered and based on a) a broad conceptualization of neuropsychology (O'Neill, 2010b), b) empirical evidence as well as c) developments in the conceptualization of models of driver behaviour (Fuller, 2005) and d) insights into the cognitive gains of later life (Robinson, 2011).

The brain maintains some degree of plasticity with age and cognitive training programs have shown their efficiency at improving healthy older adults' memory, reasoning, speed of processing and dual task performance (Mozolic, Long, Morgan, Rawley-Payne & Laurienti, 2011). While training on laboratory tasks show good results on the trained tasks, the question of whether these improvements can be transferred to everyday life situations, such as driving, remains a crucial question. The development of virtual reality and video games gives a significant acceleration of the research in this field. However, regarding video games, research has not considered the case of older people. Most of the work done in the field of cognitive training of older drivers has used more traditional computerized tasks for training, like the speed of processing component of the Useful Field of View test (UFOV) (Roenker, Cissell, Ball, Wadley & Edwards, 2003) and driving simulators (Cassavaugh & Kramer, 2009; Masson, Marin-Lamellet, Colliot & Boisson, 2009). However, most of the work has been done on pathological subgroups of older drivers, for example, stroke or Parkinson patients (Akinwuntan et al., 2005; Devos et al., 2009) and not with older drivers with normal age-related cognitive decline.

Several types of commercial software or application are available on the market but despite the claims of this widely available technology, much of it is not tested through the rigorous evaluation process necessary to ensure the product delivers what it promises. For example, most of these products are not really based on a driving behaviour model approach or do not use a relevant cognitive framework.

5.2.3 Functional cerebral imaging techniques

In cognitive neuroscience, the past 15 years have been characterised by the advent of functional cerebral imaging techniques such as fMRI or MEG (magnetoencephalography). These techniques allow us to measure brain activity while people think or carry out tasks. fMRI measures haemodynamic changes induced by regional change in neuronal activity, it has a high spatial resolution but a poor temporal resolution. MEG measures the neuronal electric or electromagnetic activity with a poor spatial resolution but a high temporal resolution. The last technique is well adapted to the studies on the different stages of information processing and allocation of attentional resources. This technique is of course not usable in real driving context but it can be used in a laboratory context, for example by driving simulation. However this will impose the use of specific equipment compatible with the MEG environment.

A first attempt was made by Bowyer et al. (2009) who studied the impact of a conversation on a visual detection task while watching a driving video. However, in this experiment, no interactions were possible between the participants and the driving scene projected. A more recent innovative experiment has been made by Fort et al. (2010) who used a simplified driving simulator, for which participants have to control the car with a steering wheel and manage the speed through pedals. While driving, participants have to react correctly to traffic signs and in a dual task situation, listen actively to radio broadcasts presented. Thirteen young male participants (aged 23-27) were involved in this study and the results showed the activation of a large distributed network similar in single and in dual task which mainly involved sensory visual areas as well as parietal and frontal regions known to play a role in selective attention. Such experiments should be extended in the near future and will be of great interest to better understand how attentional resources are working together while an older person is driving.

5.3 Traffic psychology and travel behaviour

Within traffic behavioural research, there are several recent disciplinary specific advances, and many of the theoretical, methodological and empirical advances are directly relevant for research on ageing and transport.

5.3.1 Explaining mode choice of different user groups

There is an increased understanding of travel- and transport-related choices people make and preferences they have, including choice of travel mode and travel patterns of different user groups. In their theoretical assumptions most of these studies refer to the Theory of Planned Behavior (TPB, Ajzen, 1991) and demonstrate that travel mode choice can be explained by mobility related operationalisations of the constructs attitude, subjective norm, perceived behaviour control, and intention (e.g. Bamberg, Hunecke & Blöbaum, 2007; Bamberg & Schmidt, 2003; Heath & Gifford, 2002; Haustein & Hunecke, 2007). A further relevant psychological determinant of travel mode choice is the personal norm, which is theoretically derived from the Norm Activation Model of Schwartz (1977). In contrast to the subjective norm construct of the TPB (Ajzen, 1991), the personal norm measures the intrinsic moral obligation to behave morally correctly. Several studies have demonstrated a positive effect of personal norm on the use of environmentally friendly travel modes (e.g. Harland, Staats & Wilke, 1999; Hunecke, Blöbaum, Matthies & Höger, 2001; Nordlund & Garvill, 2003). Other mobility related attitude dimensions result from symbolic-affective evaluations of travel modes (Anable & Gatersleben, 2005; Ellaway et al., 2003; Hunecke, 2000; Mann & Abraham, 2006; Steg, 2005; Steg, Vlek & Slotegraaf, 2001). Steg et al. (2001) demonstrated that symbolic-affective functions like excitement and prestige as well as instrumental-reasoned functions like financial costs and driving conditions are important dimensions underlying the attractiveness of car use. Examining the relative

importance of different instrumental and affective journey attributes, Anable and Gatersleben (2005) found that for work journeys more importance is attached to instrumental aspects, whereas for leisure journeys almost equal importance is ascribed to instrumental and affective aspects, particularly to flexibility, convenience, relaxation, and freedom. Hunecke (2000) differentiated four basic symbolic dimensions of mobility: autonomy, excitement, status, and privacy. On the background of these dimensions behaviour relevant attitudes concerning different travel modes can be operationalised (Haustein & Hunecke, 2007). It has been shown empirically that psychological factors can improve the prediction of different aspects of mobility behaviour in addition to sociodemographic and infrastructural variables (e.g. Hunecke, Haustein, Grischkat & Böhler, 2007; Van Wee, Holwerda & Van Baren, 2002). Attitudinal variables have also been used to identify different segments of the population to be used in designing targeted hard and 'soft' transport policies (Anable, 2005; Hunecke, Haustein, Böhler & Grischkat, 2010).

However, recent research has often overlooked the fact that also older persons make active choices regarding their transport. Still, there are a few studies that take attitudinal variables into account when explaining older people's mode choices (e.g. Cao et al., 2007; Haustein et al., 2008; Haustein, 2012). This is of increasing importance as with high licensure rates on the one hand and good functional health on the other hand, large parts of the new cohorts of older persons will have a real choice of transport mode. Old persons actively choose their mode of travel depending on several different factors. This will have increasing relevance when different measures are being used to encourage people to make sustainable choices. Against this background, Haustein (2012) conducted a study to increase older people's mobility options and promote more environmentally-friendly choices at the same time. Based on the most important predictors of their travel behaviour, four sub-groups of older people were identified, which showed distinct mobility patterns as well as significant differences in infrastructural, socio-demographic and attitudinal variables (see Chapter 4.7 for this and other segmentation approaches).

5.3.2 The driving task

An especially relevant advance within traffic behavioural research has been the increased understanding of the driving task, and consequently the skills needed for carrying this task out successfully and safely. Most recent driver behaviour models (e.g. Groeger, 2000; Fuller, 2000) have been influenced by Michon (1985), who suggested a model consisting of three hierarchical levels: a strategic level, a tactical level, and an operational level. A fourth motivational level has been suggested to complete the model (Hatakka, Kesinen, Gregersen, Glad & Hernetkoski, 2002). This hierarchical approach can be used to combine the motivational and attitudinal aspects with the performance aspects of driving behaviour (Hatakka et al., 2002). The four levels are described briefly in the following:

- Goals for life and skills for living (e.g. lifestyle, group norms, personal values)
- Goals and context of driving (e.g. planning and choosing routes, evaluation of necessity of trip)
- Mastery of traffic situations (e.g. traffic rules, speed adjustment)
- Vehicle manoeuvring (e.g. direction/position, tyre grip and friction)

Each level is mapped with three parameters: knowledge and skills, risk-increasing factors, and self-evolution. The idea in this hierarchical approach is, that failure as well as success at higher levels affect the demands on skills at lower levels. Still, it is not a simple top-down process as changes in lower levels also have effects on the whole system (Hatakka et al., 2002). The hierarchical model and its further developments (Bekiaris, Amditis & Panou, 2003; Hatakka et al., 2002; Peräaho, Keskinen & Hatakka, 2003) have often been applied in the context of young drivers and their training, but much less so in the context of older drivers' driving skills. Yet, the hierarchical model would have direct relevance for discussions concerning 'fitness to drive', and training and rehabilitation options for older drivers (c.f. Breker et al., 2003). Due attention to Fuller's model of task-difficulty homeostasis is also relevant to the compensatory skills of older drivers (Fuller, 2005).

5.3.3 Travel survey methods

Travel survey methods for collecting data on people's behavioural patterns in transport system have become more sophisticated and advanced, consequently being better in reaching new subgroups of respondents, describing socio-economic factors at a more nuanced level, and aiming at more harmonized data collection. However, in different European national travel surveys, the inclusion criteria for respondents are different. Although the general aim is to get a representative illustration of travel activity on a population level, not all surveys include the oldest population: in Denmark, for example, the upper age limit for respondents is 84 years. Given the demographic challenge, it is necessary to aim at better inclusion of the older population in the travel surveys. In addition, it is important that survey methods are developed into better grasping the relevant aspects regarding older population's travel that are needed for knowledge-based policy development in the future. Knowing about the heterogeneity of the (older) population, it should also be ensured that relevant subgroups can be subdivided, for example by ethnicity or living arrangement. Against the background of an internationalization and individualization of the European society, these two aspects are of special interest.

Harmonized data are a must for authorities on a European level. But in Europe different approaches and data qualities exist. The demand data from the transport sector should allow the assessment of past policies, in terms of efficiency and equity. They should also allow the elaboration of new policies measures at a European level (e.g. to reduce the emissions due to transport). For describing and analysing trends, as well as behavioural changes, conventional travel survey approaches (collecting

only one week-day travels out of school holiday periods, i.e. when traffic flows are maximal) are not enough: for example for environmental issues, mobility has to be described throughout the year.

EUROSTAT has already harmonized family expenditure and time use surveys, as well as the survey on Heavy Goods Vehicles. Harmonization of the national travel surveys in Europe has been set as a high priority issue by the European Commission, Eurostat and European statistical advisory committee. An ongoing COST action TU0804 SHANTI (<http://shanti.inrets.fr/>) is focusing on this harmonization and is mapping and reviewing the materials and methods of the different European national travel surveys.

5.4 Political science

In transport research generally, the focus has been on problems and measures to solve them. In the case of ageing and transport, traditionally the user group (i.e., older road users) has been described in terms of age and gender distribution, safety, travel patterns and problems, and in terms of design solutions or single policies that would be beneficial for them. This information is without doubt essential in order to understand who the older road users are and what their needs are about, but it gives limited understanding of how the knowledge translates into policies, and whether and how the policies can be implemented.

Recently in the field of transport research, there has been an increasing interest in applying a political approach to understand the institutional and political conditions influencing the implementation of any suggested measures. From a political science perspective, understanding who the relevant societal players are and what their agendas are is crucial for planning processes for implementation in which barriers such as goal conflicts between different players are minimized. In the area of traffic safety, for example, the need for this approach was stated already in 1997 by OECD and highlighted again in 2003 in ETSC's conference on traffic safety (Wegman, 2003). In recent years, several transport related studies in Sweden, Norway, the Netherlands and Switzerland have applied a political approach, focusing on central players and their understanding of traffic safety (Forward, Antonson, Forsberg, Thoresson & Nyberg, 2008; Forward & Ojala, 2008; Heikkinen & Hakamies-Blomqvist, 2000; Ross & Nyberg, 2005), cross-organizational co-operation in implementing policies (European Transport Safety Council, 2003; Olsen & Ravlum, 2006; Sørensen & Assum, 2005; Vägtrafikinspektionen, 2007; 2008), goal conflicts (Andersson & Vedung, 2010; European Transport Safety Council, 2003; Ross & Nyberg, 2005), changing formulations of problems, goals and important measures in relation to older drivers during history (Heikkinen, 2008), and on how science-based knowledge is used in policy making (Bax, Elvik & Veisten, 2009; Frey, 2010; SWOV, 2009).

In line with this development of applying a general political approach, Heikkinen and Hakamies-Blomqvist (2000) conducted a study in the area of older car users in Sweden to describe how different

organizations influence older drivers seen from a broad perspective. Both road safety and mobility and how the two relate to each other are discussed here. Heikkinen and Hakamies-Blomqvist view older car drivers and related questions as the centre in a scene surrounded by different actors on a macro level. Actors included in the study were government departments, the National Road Administration, County Administrative Boards, County Councils, municipalities, insurance companies, driving schools and organizations for older people. Focusing on older car drivers surrounded by actors on a macro level, the study in that way described how various actors are working on issues that directly or indirectly influence conditions for older car drivers. This study was exploratory and qualitative using information from many sources in order to create thorough descriptions of the organizations in Sweden: Interviews, official homepages of the actors on the internet, annual reports, brochures and literature.

Comprehensive politological analyses, like the one by Heikkinen and Hakamies-Blomqvist (2000), need to consider all relevant interactions in a complex socio-technical system. Ageing and transport exemplifies this in an excellent manner: policy making is built upon knowledge from various disciplines, and decisions and measures on many sectors (city planning, health care, driver legislation, etc.) affect both the mobility needs and opportunities of older people. A politological approach has so far, however, apart from a few exceptions, been largely missing in the area of ageing and transport and research on older road users. There is a clear need for more analyses on how knowledge – and which knowledge – translates into policies, how the relevant societal players co-operate, and what kind of goal conflicts there are that have a bearing on older persons' mobility. The analysis needs to consider both the consequences of actions targeting on older people's mobility and the unintended or neglected consequences of actions that target other societal issues.

6 Conclusions and recommendations

6.1 Main implications of population ageing on the transport system

In the future, more older people will hold a licence and keep driving until an advanced age. This will lead to benefits in terms of social inclusion and mobility related well-being. The continued driving of older people may also benefit other generations, both in terms of older people providing safe transport for others, and in terms of improvements of safety on a system level. This is likely to lead to an overall reduction in automobile accidents but an increase in car traffic will pose risks in terms of older people as unprotected road users (pedestrians and cyclists). A further possible substantial safety dividend is related to the disproportionate levels of death and serious injury related to a higher level of fragility, which should be addressed in vehicle adaptation and age-attuning of occupant protection (cf. Chapter 3.4.1).

Older road users are a heterogeneous group, and factors such as gender, age, socio economy, residential location, ethnicity, and housing structure influence their transport patterns and needs.

The number of older women drivers especially is expected to increase in the future (cf. Chapter 3.2), but on the other hand, older women in particular tend to give up driving too early, often because they lack confidence or are discouraged by their husbands or licence policies. Increasing women's confidence and experience in driving seems to be of special importance in order to keep older women safe and mobile (c.f. Chapter 4.2).

For rural residents, better infrastructural conditions have to be provided to ease their car-dependence and allow them to age in place. Safe alternatives to the car (as driver and passenger) need to be provided for the point when they want or have to cease driving or lack a driver. In addition, measures to increase the awareness of specific risk for rural drivers could allow them to drive longer safely (cf. Chapter 4.4).

Perceived danger is a concern of older people, especially of residents of high-density urban areas and in the growing groups of older women, the oldest old and ethnical minorities. This concern is often underestimated by experts (cf. Chapter 3.2.2). Even if trips are not avoided because of perceived fear but "only" done at a different time or in company, this concern should be addressed in adequate measures with regard to the design and maintenance of the physical environment as well as in discussions in politics, society and media with the aim of increasing awareness and providing support.

6.2 Knowledge gaps and future research directions

While literature on older people's mobility and safety often focuses on the related problems, the personal, societal and economic benefits of maintained personal mobility for older people, and in particular of driving, has been insufficiently addressed in the current literature and should be looked into in more detail.

With regard to the heterogeneity of the ageing population, there are several knowledge gaps but also some recent improvements. Knowledge on gender and mobility has definitively increased in the last few years, for example with regard to women's dependency on other, reasons and consequences of driving cessation, and (unfulfilled) mobility needs. As presented in Chapter 4, several interactions of female gender and other socio-demographic variables have been found, showing that lower income or living in a single-household has different implications for women and men. This should be addressed in future research by including these interactions in multivariate analysis and by presenting descriptive results always separately for men and women to make differences visible.

The mobility options and traffic safety vary considerably between different regions (cf. Chapter 4.4). The on-going urbanization leaves rural areas worse off in terms of services and public transportation, which increases the car dependency of seniors residing in these areas. On the other hand, urbanization means that an increasing number of persons are growing old in urban environments, which puts pressure on the urban planning and development of age friendly cities, also in terms of transport and mobility services. Future studies should address the needs of seniors living in different residential locations, in order to provide the ageing societies tools to support independent living and ageing in place.

As shown in Chapter 4.5, studies on mobility and migration background are very limited in Europe. The situation gets even worse with respect to older people's mobility. As a first step, the respective variables should be integrated in national travel surveys like already practised in the UK. However, besides descriptive results, more in-depth research on cultural effects on travel behaviour and effects of travel socialisation are needed to explain possible differences and provide suitable measures to face possible mobility problems at an early stage of immigration.

With regard to household form, some contradictory results exist. Here, simple comparisons of people in different household forms come to different conclusions than analyses that control for factors such as age and gender (cf. Chapter 4.6). Living alone primarily applies to older women and seems to have different consequences for men and women, so also interactions of gender and household-variables should be considered in future research. In addition, living with a partner (or not) and living in a single-household (or not) are often treated like comparable variables, neglecting that one can also live together with other people than a partner and that people can also have a partner in a different household context. These variables should be separated more carefully in order to receive results,

which are easier to interpret. Also, more research is needed on older people living in alternative living forms, such as living-apart-together (cf. Chapter 4.6).

Taking into account the heterogeneity of the older population, several segmentations of older people have been suggested. More research is however needed to show how stable current segments of older people are and in how far future cohorts of older people will be different (cf. Chapter 4.7).

There are disciplines, where empirical, theoretical, and methodological advances are useful, if not necessary for further understanding and studying the issue of ageing and transport. These include gerontology and geriatrics, study on traffic behaviour (traffic psychology), neuropsychology, and social and political sciences. Future studies on ageing and transport should increasingly draw upon the theories and new findings from these disciplines.

7 References

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